

Systematic studies in the eucalypts. 10. New tropical and subtropical eucalypts from Australia and New Guinea (*Eucalyptus*, Myrtaceae)

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Abstract

Hill, K.D. and Johnson L.A.S., (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 2000. Systematic studies in the eucalypts. 10. New tropical and subtropical eucalypts from Australia and New Guinea (*Eucalyptus*, Myrtaceae). *Telopea* 8(4): 503–539. New species described are *Eucalyptus biterranea*, *E. macta*, *E. grisea*, *E. pantoleuca*, *E. glomericassis*, *E. kenneallyi*, *E. costuligera*, *E. epruinata*, *E. limitaris*, *E. tephrodes* and *E. xerothermica*. New subspecies are recognised in *E. leucophloia* Brooker (subsp. *euroa*), *E. oligantha* Schauer (subsp. *modica*), and *E. pruinosa* Schauer (subsp. *tenuata*). All new taxa fall within subgenus *Symphomyrtus*, in the three sections *Transversaria*, *Exsertaria* and *Adnataria*. New taxa are mapped, and keys are presented in cases where existing keys will not discriminate taxa. Selected taxa are illustrated.

Introduction

New taxa described here are tropical species from the three sections *Transversaria*, *Exsertaria* and *Adnataria* of subgenus *Symphomyrtus* of the genus *Eucalyptus* taken in the sense of Hill and Johnson (1995), excluding the genus *Corymbia* as discussed therein. The new taxa are from New Guinea and tropical regions of Queensland, Northern Territory and Western Australia. Several of these taxa are treated as undescribed species or subspecies in the semi-popular account of tropical taxa by Brooker and Kleinig (1994). Our new taxa, discussed both here and by Brooker and Kleinig were delineated by us during a comprehensive revisionary study of the eucalypts, and were freely discussed with Ian Brooker in order to allow the treatment in Brooker and Kleinig.

Terminology and nomenclature are as in previous papers in this series (see Hill & Johnson 1995). Rare or threatened species are allocated conservation status codes according to the system of Briggs and Leigh (1996). Species authorship is to be cited as presented under each taxon described. They are not cases for the use of 'ex'. Keys are presented in cases where existing keys will not discriminate taxa, either as dichotomous keys or comparative tables. In other cases, distinctions are given that separate the new taxa from species that can be identified using the keys presented by Chippendale (1988), Brooker and Kleinig (1994) and Pryor et al. (1995).

Interpretation of *E. kenneallyi* and the extra-Australian taxa is from herbarium material only; other taxa have been interpreted on the basis of both herbarium collections and field observations of populations in situ.

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Section *Transversaria*

Adult leaves strongly dorsiventral ('discolorous'), variously hypostomatic to partly to $\pm$ completely amphistomatic; lateral veins closely spaced, parallel, at a high angle to the midrib ($> 50^\circ$). Anthers versatile, oblong, opening by parallel slits.

The group *Transversaria* as defined here comprises 23 species. Most species occur in tall, wet forests of the coast and ranges of eastern Australia, with one species in wet forests of south-western Western Australia, one extending to New Guinea and three endemic to islands of south-eastern Indonesia and East Timor.

Species of this group are abundant around Port Jackson, and were consequently recognised very early in the history of Australian botany. Four species were described before 1800 by Smith (1790, 1795, 1797). Nine species were recognised by Bentham (1867), in six different groups (six of these were species of *Transversaria* sens. strict., placed by him in three subseries of his series *Norinales*). He also reduced *E. punctata* DC. to synonymy with *E. tereticornis* Sm.

Maiden (*Crit. Revis. Eucalyptus* 1903–1933, 6: 355) recognised 17 species, placing them (with other taxa) in section *Macrantherae* subsection *Tereticornes* (excepting *E. pellita* F. Muell., which he placed in subsection *Longiores* series *Non-Corymbosae*). He went on to place most of these in his seed series *Lepidotae-Fimbriatae*. Neither Maiden nor Bentham considered critical features of leaf morphology in their classifications.

Blakely (1934) recognised a series *Transversae* based on leaf venation, and made up of all then known taxa that we now place in *Transversaria*. Twenty species were included, several of which have since been reduced to synonymy. Blakely also included *E. cladocalyx* F. Muell. The latter was excluded from the series by Pryor and Johnson (1971), who otherwise included the same taxa as Blakely. Nomenclatural problems with taxa in the Indonesian Islands were resolved with the description of *E. urophylla* by Blake (1977), and further taxonomic difficulties in this group were resolved by Pryor et al. (1995), with the recognition of two additional species (see Table 1).

Chippendale (1988) used six series names to cover the group, including *E. longifolia* Link & Otto with the grey gums (the *E. punctata* group; series *Punctatae* herein). We now regard the *E. longifolia* group as sectionally distinct, and recognise five series within the section *Transversaria* as here circumscribed (Table 1). Brooker (2000) segregated the Western Australian species *E. diversicolor* into a separate section based largely on positioning of valves in fruit, and coined the sectional name *Latoangulatae* for the remaining taxa included here in *Transversaria*.

Table 1. A classification of section *Transversaria*

Section *Transversaria*

Series *Diversicolores*

E. diversicolor

Series *Deaneanae*

E. brunnea

E. deanei

Series *Salignae*

Subseries *Salignosae*

E. grandis

E. saligna

E. botryoides

Subseries *Robustosae**E. robusta*Series *Resiniferae**E. urophylla**E. orophila**E. wetarensis**E. biterranea**E. pellita**E. scias*subsp. *tanyula*subsp. *scias*subsp. *callimastha**E. notabilis**E. resinifera*subsp. *hemilampra*subsp. *resinifera**E. macta*Series *Punctatae*Subseries *Propinquosae**E. major**E. propinqua*Subseries *Punctatosae**E. biturbinata**E. canaliculata**E. punctata**E. grisea**E. longirostrata*Series *Resiniferae*

Bark persistent or mostly so, shortly fibrous. Disc raised or level, rarely depressed.

1. *Eucalyptus biterranea* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. pellita* distinguitur: alabastra, fructus et folia minora, fructus saepissime angustiores.

Type: Queensland, N. slope of Mt Tozer (12°45'S, 143°12'E), K. Hill 1862, P. Hind & D. Healey, 28 July 1986 (holo NSW; iso BRI, CANB, PERTH).

Tree to 25 m tall. Bark persistent to larger branches, long fibrous-flaky, reddish-brown underneath, smooth, grey above. Juvenile leaves disjunct, ovate acuminate, petiolate. Adult leaves lanceolate to broad lanceolate, dorsiventral, hypostomatic except for a few scattered stomata adjacent to the adaxial midrib, disjunct, 70–200 mm long, 20–50 mm wide; petioles 12–35 mm long; lateral veins closely-spaced, regular, at 45°–60° to midrib, closely and regularly reticulate between; intramarginal vein distinct, 0.5–2 mm from margin. Inflorescence simple, axillary; umbellasters 7-flowered. Peduncles flattened, 9–18 mm long, to 3 mm wide at apex. Pedicels terete or angular, 4–12 mm long. Mature buds ovoid to broadly fusiform, 14–18 mm long, 7–9 mm diam.; calyptra

1.5–2 times longer than hypanthium, inflated conical, shortly and broadly rostrate. Stamens all fertile, filaments erect in bud, anthers oblong, dorsifixed, versatile, dehiscent by parallel slits. Fruits cup shaped, 3- rarely 4–5-locular, 7–11 mm long, 7–11 mm diam.; hypanthium smooth; calyptra scar and stemonophore broad, raised; disc depressed; valves vertically exserted, triangular, apiculate.

Previously confused with and included in *E. pellita*, which we now regard as an Australian endemic restricted to the Cairns region. *E. biterranea* is distinguished from *E. pellita* by the smaller buds, fruits and leaves (Table 2). It is the only species in section *Transversaria* occurring in New Guinea, readily distinguished from other eucalypt species in the region by the strongly discolorous leaves with closely parallel pinnate venation, and the fruits with prominently exserted valves. This is the taxon referred to as species A by Pryor et al. (1995), who also discuss diagnostic features of the Indonesian and Timorese taxa. It is distinguished from *E. orophila* and *E. wetarensis* by the calyptra more than 1.5 times the length of hypanthium in bud (about equal in the other species), and from *E. urophylla* by the broad fruits, about as long as wide (fruits are longer than wide in *E. urophylla*).

Table 2. A comparison of the tropical Australian red mahogany species

	<i>E. biterranea</i>	<i>E. pellita</i>	<i>E. macta</i>	<i>E. resinifera</i>
leaves, l × b mm	70–200 × 20–50	110–200 × 35–75	70–180 × 12–35	90–220 × 20–45
petiole mm	12–35	18–25	15–25	15–30
peduncles mm	9–18	15–25	5–25	9–20
pedicels mm	4–12	5–10	3–12	4–10
buds, l × b mm	14–18 × 7–9	13–16 × 7–10	14–21 × 6–8	14–20 × 5–6
fruits, l × b mm	7–11 × 7–11	10–13 × 9–18	7–10 × 7–10	6–10 × 6–9

Distribution: sporadic in distribution, through the MacIlwraith and Iron ranges and northwards in Australia, the southern margin of the Oriomo Plateau in the Western Province of Papua New Guinea, and the south-east of the Merauke region in Irian Jaya (Fig. 1).

Ecology: usually a tree of rainforest margins.

Conservation status: not considered to be at risk.

Etymology: from the Latin *bi-*, two, and *terra*, a land or region, in reference to the species occurrence in both far north Queensland and the island of New Guinea (Papua New Guinea and Irian Jaya).

Selected specimens (from 15 examined): Australia: Queensland: Cape Flattery, *Bean* 469, 24 June 1986 (NSW); 9 km W of Barrow Point, Cape York Peninsula, Cape Melville National Park, *Fell* DGF3347 & *Stanton*, 21 July 1993 (BRI, CANB, NSW); McIlwraith Range, *Hyland* 7659, 22 Sep 1974 (QRS, NSW); T.R. 14, McIlwraith Range, Leo Ck road, *Hyland* 8411, 22 Sep 1975 (QRS, NSW); Tozers Gap, *Irvine* 227, 30 June 1972 (QRS, NSW).

Papua New Guinea: Western Province: Approx. 6 km S of Keru on road to Mata, *Gunn* 838, 22 Sep 1987 (NSW); Approx. 1.2 km S of Kumbalusi to [wards] Mata, *Gunn* 849, 850, 22 Sep 1987 (NSW); Approx. 20 minutes North of Tokwa on road to Kiriwo, Sirisa, *Gunn* 865, 871, 29 Sep 1987 (NSW); SW of Goe (half a days walk or about 9 km), 12 km N of Kiriwo, *Gunn* 882, 885, 1 Oct 1987 (NSW); new track to mining camp S of Maru, *McDonald* 837, 23 Oct 1988 (CANB, NSW).

Indonesia: Irian Jaya: Merauke: Djidjurug, *Long* BW569 (NSW).

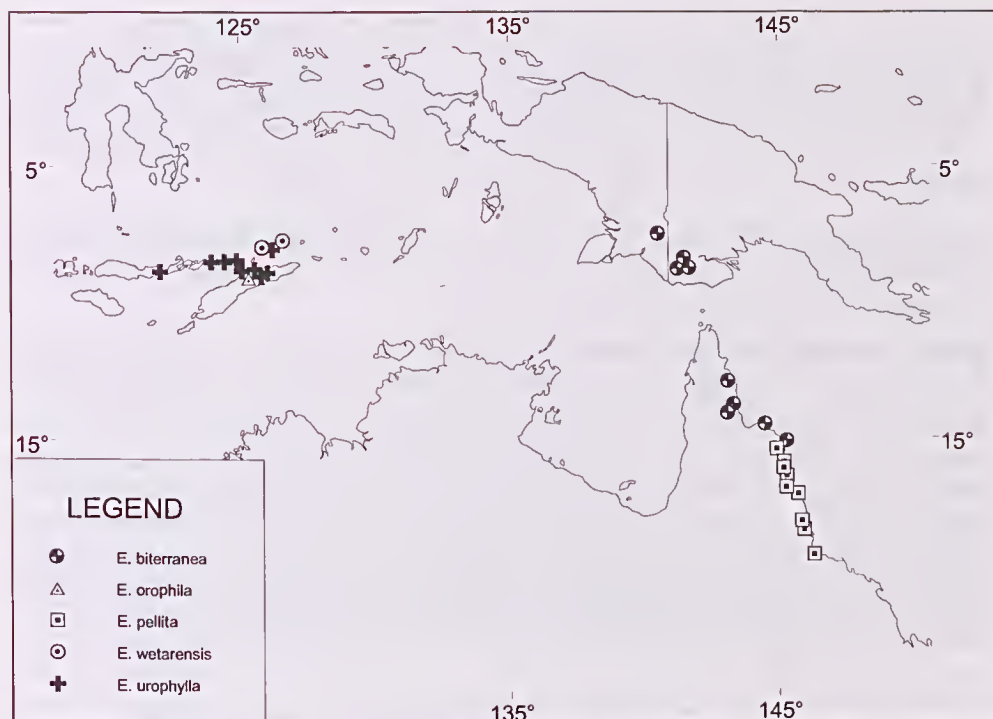


Fig. 1. Distribution of *E. biterranea*, *E. orophylla*, *E. pellita*, *E. wetarensis*, *E. urophylla*.

2. *Eucalyptus macta* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. resinifera* distinguitur: calyptra diametro majore, brevior, plus rostrata; fructus major, latior et relative brevior; discus descendens, valvae robustiores et prominenter exsertae.

Type: Queensland: Wild River, 2.5 km east of Herberton on Atherton road, Hill 1115, Johnson & Blaxell, 15 Aug 1984 (holo NSW; iso BRI, CANB, DNA).

Tree to 25 m tall. Bark persistent to smallest branches, long fibrous-flaky, reddish-brown underneath. Juvenile leaves disjunct, ovate, acuminate, petiolate. Adult leaves lanceolate, dorsiventral, hypostomatic except for a few scattered stomata adjacent to the adaxial midrib, disjunct, 70–180 mm long, 12–35 mm wide; petiole 15–25 mm long; lateral veins closely-spaced, regular, at 45°–60° to midrib, closely and regularly reticulate between; intramarginal vein distinct, 0.5–2 mm from margin. Inflorescence simple, axillary; umbellasters (7–)11-flowered. Peduncles flattened, 5–25 mm long, to 4 mm wide at apex. Pedicels terete or angular, 3–12 mm long. Mature buds ovoid to fusiform, 14–21 mm long, 6–8 mm diam.; calyptra 2–3 times longer than hypanthium, usually broadly rostrate for about 1/2 length. Stamens all fertile, filaments erect in bud, anthers oblong, dorsifixed, versatile, dehiscing by parallel slits. Fruits cup-shaped, 3–4-locular, 7–10 mm long, 7–10 mm diam.; calyptra scar and stemonophore broad, steeply raised, 1–1.5 mm wide; disc depressed or level and incurved, 1–2 mm wide; valves vertically exserted, triangular, apiculate.

E. macta is distinguished from *E. resinifera* Sm. by the broader, shorter, more rostrate calyptra, and the larger, broader and relatively shorter fruit with a descending disc and heavier, more prominently exserted valves (Table 2).

Distribution: Queensland: Sporadically distributed in highland areas of North Queensland, the MacIlwraith range, Atherton Tableland and Eungella range (Fig. 2).

Ecology: a component of wet sclerophyll forests in sheltered gullies on sandy soils over granite, sandstone or acid volcanic rocks. Associated species include *E. tereticornis*, *E. eugenoides* Sieber ex Sprengel, *Corymbia tessellaris* (F. Muell.) K.D. Hill & L.A.S. Johnson and *C. intermedia* (R. Baker) K.D. Hill & L.A.S. Johnson.

The epithet is from the Latin *mactus*, magnified, referring chiefly to the fruit characters as compared to those of *E. resinifera*.

Conservation status: not considered to be at risk.

Selected specimens (from 19 examined): Queensland: 8 miles [12.8 km] from Atherton towards Herberton, *Brooker* 3393, 28 Jan 1972 (CANB, NSW); ridge between Herberton and Atherton, *Brooker* 4123, 23 Aug 1973 (CANB, NSW); 7 km along Bennetts Road, NW of Eungella, *Brooker* 5250, 21 July 1996 (CANB, NSW); forestry road, west of Atherton to Herberton road, *Brooker* 6510, 9 Oct 1979 (CANB, NSW); west of Paluma, *Crowley* 158, 11 Feb 1985 (NSW); 8 km east of Hidden Valley on Paluma road, *Hill* 1154, *Johnson & Blaxell*, 18 Aug 1984 (NSW, BRI, CANB, PERTH); Herberton Range, *Hyland* 5142, 7 June 1971 (QRS, NSW); SFR 144, *Hyland* 5699, 16 Nov 1971 (QRS, NSW); SFR 194, *Hyland* 5718, 2 Dec 1971 (QRS, NSW); Tinaroo Hills, *Hill* 1148 & *Johnson*, 17 Aug 1984 (NSW); tablelands, Herberton district, *Mocatta* 16, Dec 1915 (NSW); Portion 42, Tarzali, *Stocker* 1496, 30 July 1976 (QRS, NSW); 1.3 km SE of Wallum Trig, Herberton Range, on forestry track, *Weston* 1800 & *Brown*, 8 July 1994 (NSW); Mt Spurgeon, *White* 10701, Sep 1936 (BRI, NSW).

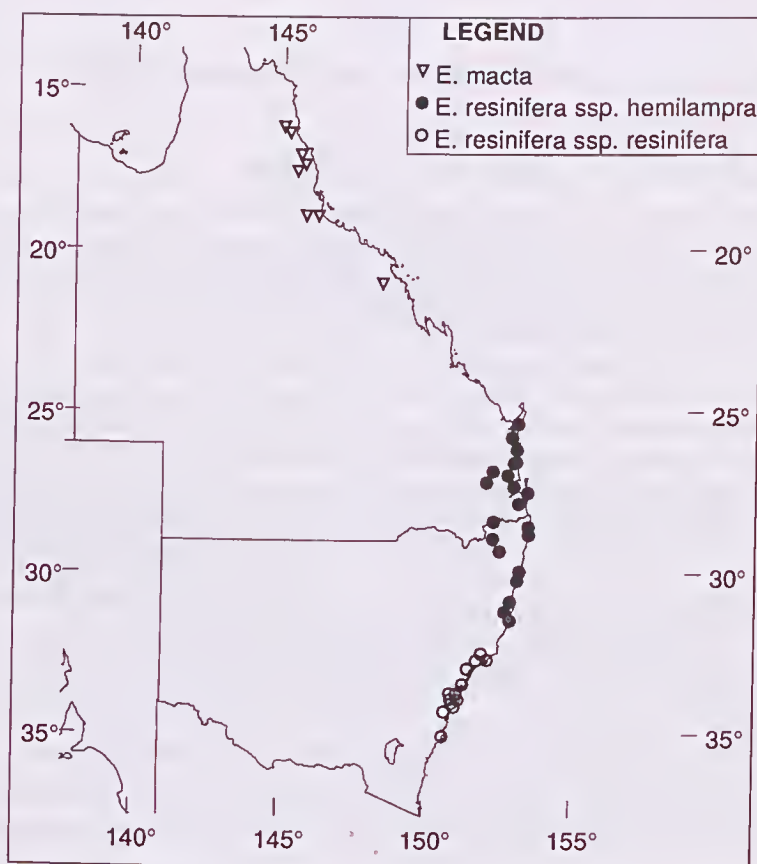


Fig. 2. Distribution of *E. macta*, *E. resinifera*.

Series *Punctatae*

Bark smooth, shedding irregularly in scales or large flakes over several years, leaving a dull surface becoming granular with age. Juvenile leaves petiolate, opposite for 4–6 nodes. Adult leaves dorsiventral, variously hypostomatic to amphistomatic. Umbellasters 7-or-more-flowered. Disc broad, raised.

3. *Eucalyptus grisea* L.A.S. Johnson & K.D. Hill, *sp. nov.*

Inter subseriem *Punctatosas* distinguitur combinatione characterum sequentium: folia juvenilia adultaque lata, calyptra moderate rostrata, pedunculus valide applanatus.

Type: Queensland: Vicinity of Pumphole Spring N of Dooloogarah Creek, NW of Mt Moffatt homestead, *Martensz 1131 & Johnston*, 3 Feb 1977 (holo NSW; iso AD, BRI, CANB, MEL).

Tree to 28 m. Bark smooth, patchy, dark grey brown, grey, orange, cream and whitish. Seedling leaves opposite for c. 3–4 nodes. Juvenile leaves disjunct, hypostomatic, oblong-ovate, apically rounded, to 100 mm long, 30–50 mm wide, petiolate. Adult leaves disjunct, hypostomatic, ovate-lanceolate, acuminate, sometimes falcate, 100–180 mm long, 30–60 mm wide, petioles 15–40 mm long. Lateral veins not closely spaced, anastomosing, at 45–60° to midrib, intramarginal vein distinct, about 1 mm from margin. Inflorescence simple, axillary; umbellasters 7-flowered. Peduncles strongly flattened, to 4 mm wide, 10–20 mm long. Pedicels angled, 2–5 mm long. Mature buds oval, 6–8 mm long, 4–5 mm in diameter. Calyptra as long as hypanthium, rounded and shortly rostrate, outer calyptra scar present as a more or less distinct lip. Fruit cup-shaped, 8–10 mm long, 7–12 mm in diameter. Calyptra scar a shallow groove c. 0.5 mm wide, stemonophore a narrow ridge. Disc slightly raised or flat, ultimately incurved and enclosing valve bases, 1.5–3 mm wide. Valves broadly triangular, apiculate, exserted and incurved at c. 45°. Seeds glossy, brown, angular, cuboid, c. 1 mm long, chaff similar, longer and narrower.

E. grisea is distinguished in the subseries *Punctatosae* by the combination of the broad juvenile and adult leaves, the beaked calyptra and the strongly flattened peduncle.

Distribution: Queensland: Consuelo Tableland, Carnarvon Range, west of Bundaberg (Fig. 3).

Ecology: locally common in tall woodland or open forest on basalt-derived clay loam, in association with *E. melanophloia* F. Muell., *E. tereticornis*, *E. laevopinea* R. Baker, *E. melliodora* A. Cunn. ex Schauer and *Corymbia erythrophloia* (Blakely) K.D. Hill & L.A.S. Johnson. This species is notable in that it grows on deep heavy clay soils over basalt, in marked contrast to other members of the *Punctatosae*. In some areas of this species range, however, basalts and sandstones are closely associated, and characteristically sandstone species such as *Corymbia hendersonii* K.D. Hill & L.A.S. Johnson grow in close proximity.

Conservation status: not considered to be at risk.

The epithet is from the late Latin, *griseus*, 'grey', referring to the bark of the mature tree.

Selected specimens (from 14 examined): Queensland: top of The Knoll, E of Van Dyke Creek, Buckland Tableland, *Bean 799*, 16 Apr 1988 (NSW); between Kookaburra Cave turnoff and Consuelo Tableland, NW of Injune, *Brooker 4869*, 28 Apr 1975 (CANB, NSW); approach from west to Consuelo Tableland, Carnarvon National Park, *Brooker 4874*, 28 Apr 1975 (CANB, NSW); Great Dividing Range, c. 80 km SW of Rolleston, Peawaddy Gorge lookout, *Crisp 3049*, 15 June 1977 (CBG, BRI, CANB, L, NSW); 0.3 km N of 3rd crossing of Dawson River, 60 km N of Injune, *Hill 4815*, 1 Oct 1996 (NSW, BRI, CANB); c. 3 km N of Pumphole Spring & Dooloogarah Creek, Great Dividing Range, *Martensz 1137, 1138 & Johnston*, 4 Feb 1977 (CANB, BRI, MEL, NSW); c. 6 km N of Dooloogarah homestead and N of Dooloogarah Creek, Great Dividing Range, *Martensz 1158 & Johnston*, 5 Feb 1977 (CANB, BRI, MEL, NSW).

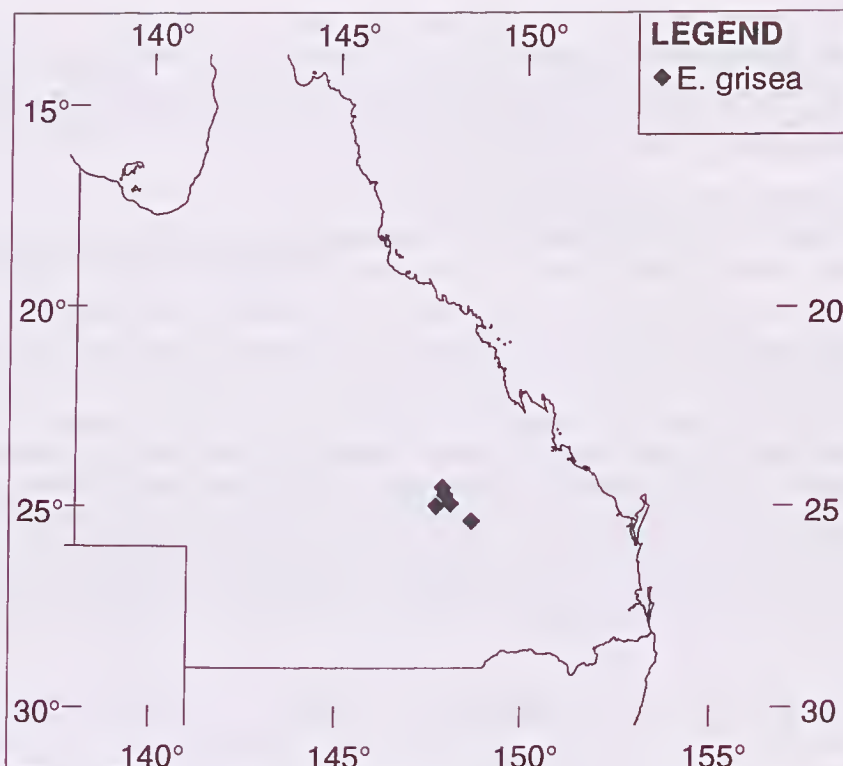


Fig. 3. Distribution of *E. grisea*.

Section *Exsertaria*, the Red Gums

Cotyledons shallowly obreniform. Juvenile leaves linear to ovate, petiolate, opposite for 3–6 nodes (more in neotenous species of series *Albae*). Adult leaves similifacial, venation open, reticulate, more than one oil gland per vein island. Oil glands not present in pith. Bark shedding regularly, or irregularly in $\pm$ large flakes, or persistent, shortly fibrous-flaky. Calyptra clearly divided into calycine and corolline segments, calycine calyptra shed very early or retained until near anthesis in some members of series *Bancroftianae*. Filaments erect or inflexed in bud. Anthers obovate, dorsifixed, versatile, cells distinct, dehiscing through long parallel slits. Gland relatively large, ovate or orbicular. Filaments gently apically tapered to a fine point attached near gland. Disc lobed in bud, inner face free from ovary; or disc absent in bud, upper wall of ovary differentiating to form a raised, disc-like structure in fruit. Ovules usually in 6 vertical rows on placenta, rarely 4 or 8. Seeds variably shaped, variably reticulate, reticulum sharp-edged; hilum ventral or terminal; testa single or double.

The 'Red Gums' are a complex group comprising four series, parts of series *Albae* and *Brevifoliae* being discussed here. The red gum group is difficult to diagnose, and not unequivocally monophyletic. Possible synapomorphies for the group are the narrowed nectary disc, the proliferation of rows of ovules on the placenta, and the openly reticulate venation with several oil glands per vein island. Within the group, series *Terticornes* and *Bancroftianae* show apomorphic seed coat characters, and the erect filaments and terminal hilum may be synapomorphies uniting the two groups. Series *Albae* shows variation in seed coat character, although within a relatively narrow range, and series *Brevifoliae* shows distinct apomorphic seed structure. The

very thinly peeling bark leaving a powdery salmon or orange fresh surface is uniform in the two groups, and may be a synapomorphy, as may also the disjunct, petiolate, rounded juvenile leaves. The thickened inner calyptra is apomorphic in series *Albae*, although not clearly present in all species of the series. The thickened valves are also apomorphic in this series.

The most likely sister group to the red gums is section *Transversaria*, which shows similarities in seed coat structure, the proliferation of ovules on the placenta, and the subterminal hilum in some groups (although the latter is possibly a result of close packing caused by the increased number of rows of ovules).

The first Red Gum to be described was *E. tereticornis* Sm. (1791). Bentham (1867) recognised two Red Gum species, which he included in Series *Normales* subseries *Subexsertae* (together with members of Sections *Transversaria*, *Bisectaria*, *Maidenaria* and *Aduataria* sensu Pryor & Johnson, 1971).

Maiden (*Crit. Revis. Eucalyptus* 1903–1933, 6) recognised five species, placed in section *Macrantherae* of his anther classification. These he then placed (with many other species) in subsection *Tereticornes* series *Leiophloiae* and *Lepidophloiae*, and subsection *Longiores* series *Non-Corymbosae*.

Blakely (1934) recognised 10 species and four varieties (three of which are here treated as species), placing them in widely different groups (Table 3).

Table 3. Placement of tropical red gum species by Blakely (1934)

Species	Section	Subsection	Series	Subseries
<i>E. herbertiana</i>	<i>Macrantherae</i>	<i>Tereticornes</i>	<i>Exsertae</i>	<i>Phaeoxyla</i>
<i>E. confluens</i>	<i>Macrantherae</i>	<i>Tereticornes</i>	<i>Exsertae</i>	<i>Erythroxyla</i>
<i>E. brevifolia</i>	<i>Macrantherae</i>	<i>Tereticornes</i>	<i>Subexsertae</i>	<i>Argophloiae</i>
<i>E. alba</i>	<i>Macrantherae</i>	<i>Tereticornes</i>	<i>Subexsertae</i>	<i>Argophloiae</i>
<i>E. platyphylla</i>	<i>Macrantherae</i>	<i>Tereticornes</i>	<i>Subexsertae</i>	<i>Argophloiae</i>
<i>E. bigalerita</i>	<i>Macrantherae</i>	<i>Tereticornes</i>	<i>Subexsertae</i>	<i>Argophloiae</i>
<i>E. houseana</i>	<i>Macrantherae</i>	<i>Normales</i>	<i>Argyrophyllae</i>	
<i>E. apodophylla</i>	<i>Macrantherae</i>	<i>Normales</i>	<i>Argyrophyllae</i>	
<i>E. mooreana</i>	<i>Macrantherae</i>	<i>Normales</i>	<i>Argyrophyllae</i>	
<i>E. umbrawarrensensis</i>	<i>Micrantherae</i>	<i>Subulatae</i>		

Blake (1953) recognised seven species, placing them (along with many other species) in four different series.

Pryor and Johnson (1971) grouped the red gums in section *Exsertaria*, with three series. The first was series *Albae*, comprising eight published species and forshadowing three new species and reduction of three of Blakely's species to subspecies. This arrangement included all of the then known taxa except the problematical *E. umbrawarrensensis* Maiden, but also included the taxon later published as *E. urophylla* S.T. Blake, now known to belong to Section *Transversaria*. All remaining red gums were placed in series *Tereticornes*, and the enigmatic *E. michaeliana* Blakely was placed in a third monotypic series in this section.

Chippendale (1988) followed the series of Pryor and Johnson, with the recognition of all of Blakely's species and the inclusion of *E. umbrawarrensensis* (following Johnson 1972),

recognising 15 species in series *Albae*. This included four recently described species (post Pryor & Johnson), and excluded *E. urophylla*. Other red gum series also followed Pryor and Johnson. Brooker and Slee (1994) departed from this arrangement, separating the *E. brevifolia* F. Muell. group as a separate series *Brevifoliae* on the basis of autapomorphic seed coat characters. Brooker (2000) presents another approach to the red gum group, dividing it into three sections with no further comment on possible relationships and placing *E. michaeliana* in a fourth section.

We now recognise that four series are discernible (Table 4), but would still regard them as allied and falling within section *Exsertaria* as diagnosed above (excluding *E. michaeliana*). A total of about 48 species make up the section, with 20 species in the two series *Albae* and *Brevifoliae*. Most species in these two series occur in areas that have until recently been poorly collected, and confusion has surrounded species determination and nomenclature. The *Eucalyptus alba* group (subseries *Albosae*) presents a number of taxonomic problems in Indonesia, Timor and Papua New Guinea, and will be discussed elsewhere.

Table 4. A classification of the red gums, section *Exsertaria*

Section *Exsertaria*

Series *Albae*

Subseries *Albosae*

E. alba
E. tintinnans
E. platyphylla
E. bigalerita
E. houseana
E. apodophylla

Subseries *Mooreanosae*

E. mooreana
E. pantoleuca

Subseries *Herbertianosae*

E. glomericassis
E. herbertiana
E. cupularis
E. gregoriensis

Subseries *Hallianosae*

E. hallii

Series *Brevifoliae*

E. rupestris
E. kenneallyi
E. umbrawarrensii
E. confluens
E. brevifolia
E. leucophloia
 subsp. *leucophloia*
 subsp. *euroa*
E. ordeana

Series *Bancroftianae*

E. seeana
E. disclusa
E. interstans
E. prava
E. bancroftii
E. parramattensis
 subsp. *decadens*
 subsp. *parramattensis*

Series *Tereticornae*

Subseries *Tereticornosae*

E. amplifolia
 subsp. *amplifolia*
 subsp. *sessiliflora*

E. tereticornis

E. glaucina

E. kabiana

E. blakelyi

E. chloroclada

E. terrica

E. dealbata

E. dwyeri

E. vicina

E. nandewarica

E. flindersii

Subseries *Camaldulensosae*

E. camaldulensis

E. obtusa

E. rudis

Subseries *Exsertosae*

E. brassiana

E. lockyeri

E. exserta

E. ammophila

E. nudicaulis

E. morrisii

E. gillenii

Key to the series

- 1 Seeds glossy red Series **Bancroftianae**
- 1* Seeds not glossy red
 - 2 All or some filaments erect in bud, hilum terminal Series **Tereticornes**
 - 2* Filaments not erect in bud, hilum ventral
 - 3 Seeds brownish-black, ragged and deeply reticulate..... Series **Albae**
 - 3* Seeds yellow-brown or pale brown, smooth and shallowly reticulate
..... Series **Brevifoliae**

Series **Albae**

Bark wholly smooth, shed regularly in thin flakes, trunks usually at first salmon or orange, becoming 'powdery' white. Juvenile leaves becoming disjunct very early (except in neotenous species), broad-lanceolate or ovate to orbicular. Outer calyptra shed early in development. Inner calyptra $\pm$ hemispherical, $\pm$ thickened. Stamens inflexed in bud. Nectary disc absent in bud, narrowed in fruit. Valves $\pm$ thickened. Seeds brownish-black, ragged and deeply reticulate.

Distributed almost entirely within savanna woodland country of the monsoon tropics, a single species occurring further south on the Queensland coast (*E. hallii* Brooker near Bundaberg). Four subseries are recognised.

- Subseries *Albosae* Juvenile leaves more or less orbicular, disjunct.
- Subseries *Mooreanosae* Juvenile leaves orbicular, opposite
- Subseries *Herbertianosae* Juvenile leaves lanceolate to ovate, disjunct.
- Subseries *Hallianosae* Juvenile leaves large, lanceolate to ovate, falcate, disjunct.

Subseries **Mooreanosae**

Adult leaves opposite, orbiculate.

Although apparently paralleling the neotenous condition occurring in some other eucalypt groups, this condition is not strictly neotenous in this group. In this case, the first few pairs of juvenile leaves are opposite, broad-lanceolate and petiolate; later juvenile leaves remain opposite but become orbiculate (and sessile in *E. mooreana*), and adult leaves retain the latter condition.

3. *Eucalyptus pantoleuca* L.A.S. Johnson & K.D. Hill, *sp. nov.*

Ab *E. mooreana* distinguitur: alabastra, fructus et folia majora, folia adulta petiolata et habitus arborescens in arenosis planitierum saepe inundatarum.

Type: Western Australia: 10 km W of 'Tableland' homestead, L.A.S. Johnson 2019, 21 Aug 1967 (holo NSW).

Tree to 12 m tall, usually less than 6 m, often of twisted habit. Bark smooth throughout, powdery, white or salmon, orange or pink, shedding in large plates or flakes. Juvenile leaves lanceolate to ovate, dull grey green, petiolate. Adult leaves opposite to subopposite, ovate to suborbiculate or orbiculate, not falcate, obtuse or rounded, basally rounded or cordate, dull, glaucous, coriaceous, concolorous, 90–130 mm long, 70–100 mm wide; petioles narrowly flattened, decurrent into ridges on stems, 20–30 mm

long; lateral veins prominent, obtuse, widely spaced, regular, reticulum complete; intramarginal vein obscure, looped, 2–4 mm from margin. Inflorescence simple, axillary; umbellasters 3-flowered. Peduncles terete or angular, thick, 8–20 mm long. Pedicels angular, 0–5 mm long. Buds ovoid or globose, glaucous, 17–24 mm long, 14–20 mm diam.; calyx calyptrate; shedding early; corolla calyptrate, free from calyx; calyptra hemispherical, smooth, about as long as hypanthium, wider than hypanthium; hypanthium smooth or angular. Flowers cream or yellow, all stamens fertile, filaments inflexed in bud, anthers versatile, oblong, dehiscing by parallel slits; style base not sunken. Fruits conical, pedicellate, 3–4-locular, smooth to ribbed or angular, 18–24 mm long, 16–20 mm diam.; calyptra scars forming a flat or slightly raised rim to 3 mm wide; stemonophore evident as a distinct narrow groove to mm wide; disc flat or slightly raised, less than 1 mm wide; valves exserted, raised at 30–60°. Seeds irregular, ovoid, shallowly reticulate, dull, dark brown, 1–2 mm long; hilum ventral. Chaff dimorphic, linear and cuboid, similar in colour to seeds. (Fig. 4).

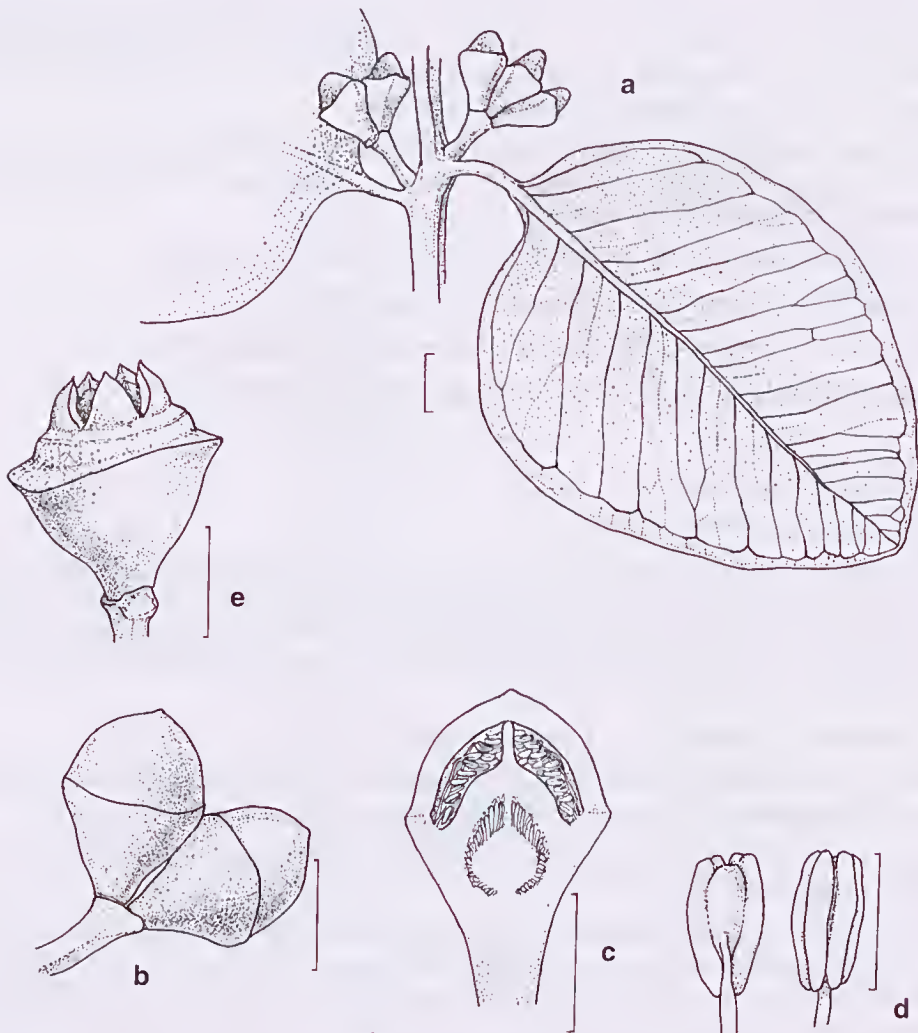


Fig. 4. *E. pantoleuca*. a, adult leaves, inflorescences and buds; b, inflorescence and buds; c, transverse section of bud; d, anther; e, fruit. (from Johnson 2019). Scale bar: a, b, c, e = 10 mm; d = 0.5 mm.

E. pantoleuca is most closely allied to *E. mooreana* W.V. Fitzg. ex Maiden, differing in the larger buds, fruits and leaves, the distinctly petiolate adult leaves (sessile and sometimes connate in *E. mooreana*), and the flood-plain habitat.

Distribution: Western Australia, north and east Kimberley region (Fig. 5).

Ecology: sporadically distributed on sandy soils, usually on low-lying areas on flood-plains or seasonally wet areas.

Occasional hybrids with *E. camaldulensis* var. *obtusa* are known in areas where the two species occur in proximity.

The epithet is from the Greek, *panto*, 'entirely', and *leukon*, 'white', referring to the distinctly glaucous, white nature of the entire plant.

Conservation status: although locally common, populations are widely separated and erratically distributed (3R).

Selected specimens (from 18 examined): Western Australia: Gibb River Rd, *Dunlop 6038 & Done*, 11 Nov 1981 (DNA, BRI, CANB, DNA, MEL, NSW, PERTH); ca 8 km E of Reed Spring Yard, W of Tableland Homestead, *George 15160*, 18 June 1978 (PERTH, NSW); 40 km W of Kununurra on Wyndham rd, *Hill 936, Johnson & Benson*, 23 July 1984 (NSW); 25 km W of Durack River crossing on Kununurra to Gibb River rd, *Hill 946, Johnson & Benson*, 23 July 1984 (NSW, CANB, DNA, PERTH); 65 miles [104 km] S of Kalumburu Mission, North Kimberleys, *Lazarides 4971 & Speck*, 9 Sep 1954 (CANB, NSW); 11 miles [17.6 km] E of Gibb River Station, Kimberleys, *Lazarides 4991 & Speck*, 12 Sep 1954 (CANB, NSW); 10 miles [16 km] SE of Tableland Station, Kimberleys, *Lazarides 5116*, 18 Apr 1955 (CANB, NSW); 6 miles [9.6 km] W of Tableland Station, Kimberleys, *Lazarides 6413*, 22 July 1959 (CANB, NSW); 25 miles [40 km] NE of Karunjie Station, *Perry 3091*, 29 July 1952 (CANB, BRI, DNA, K, MEL, NSW, PERTH, US).

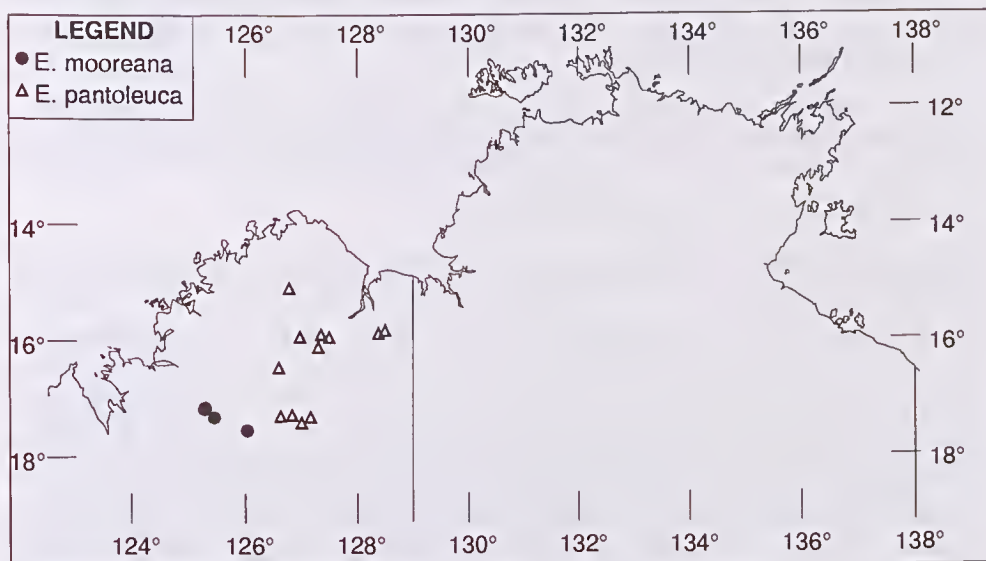


Fig. 5. Distribution of *E. mooreana*, *E. pantoleuca*.

Subseries *Herbertianosae*

Juvenile and adult leaves disjunct, petiolate. Juvenile leaves lanceolate to ovate. Disc narrow. Valves thick.

4. *Eucalyptus glomericassis* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. cupulare* et *E. herbertianae* distinguitur: folia longa, lucide viridia, alabastra saepe verrucosa et calyptra latissima.

Type: Northern Territory: Deaf Adder Gorge, (13°02'S 132°57'E), C. Dunlop 4344, 21 Feb 1977 (holo NSW; iso DNA).

Tree to 10 m tall. Bark smooth throughout, white to grey, brown or pink, shedding in large plates or flakes. Adult leaves disjunct, narrow lanceolate to lanceolate, often falcate, acuminate, basally tapered, highly glossy, green, concolorous, 120–250 mm long, 8–35 mm wide; petioles narrowly flattened or channelled, 12–27 mm long; lateral veins prominent, acute, widely spaced, irregular; reticulum complete; intramarginal vein distinct, continuous, 0.5–1 mm from margin. Inflorescence simple, axillary; umbellasters 7-flowered. Peduncles terete or weakly angular, 6–16 mm long. Pedicels terete or angular, 1–5 mm long. Buds ovoid or globose, 7–8 mm long, 5–6 mm diam.; calyx calyptrate; shedding shortly before anthesis; corolla calyptrate, free from calyx; calyptra hemispherical, smooth or irregularly verrucose, about as long as hypanthium, wider than hypanthium; hypanthium smooth or verrucose. Flowers white or cream, all stamens fertile, filaments irregularly inflexed in bud, anthers versatile, oblong, dehiscing by parallel slits; style base not sunken. Fruits hemispherical or conical, 4–5-locular, smooth or verrucose, 7–9 mm long, 7–9 mm diam.; calyptra scar raised at 60–90°, 0.5–1.0 mm wide, ± stepped inside hypanthium; stemonophore raised, 0.5 mm wide; disc raised, ultimately incurved, 1.5–2.5 mm wide; valves broadly triangular, exserted, vertically raised, somewhat incurved at tips. Seeds irregularly ovoid to pyramidal, shallowly reticulate, semi-glossy, dark brown, 1.5–2 mm long; hilum ventral. Chaff dimorphic, linear and cuboid, similar in colour to seeds. (Fig. 6).

E. glomericassis differs from *E. cupularis* C. Gardner, *E. gregoriensis* N.G. Walsh & D.E. Albrecht and *E. herbertiana* Maiden in the long, narrow glossy green leaves and the often verrucose buds with a broad hypanthium and an even broader calyptra.

Distribution: Northern Territory: known only from the sandstone massifs of Kakadu and western Arnhem Land (Fig. 7).

Ecology: restricted to skeletal soil on very rugged sandstone country, often along watercourses but not in deep gorges. Almost always near the broken eroded edges of the plateau rather than on the relict surface of the actual plateau.

Conservation status: not considered to be at risk.

The epithet is from Latin *glomus*, *glomeris* a ball and *cassis* a helmet, referring to the shape of the calyptra.

Selected specimens (from 24 examined): Northern Territory: Mt Brockman plateau Kakadu National Park, Boland 2129, 2130, 2131, 2132, 2133, 2134 & Wardman, 17 Nov 1984 (CANB, NSW); hilltop W of Nabarlek, Arnhem Land, Brooker 5358, 2 Oct 1976 (CANB, NSW); Magela Creek, Dunlop 3369, 25 Feb 1973 (DNA, NSW); SW Nablek, Dunlop 4289, 20 Oct 1976 (DNA, NSW); 44 km SE Oenpelli, Dunlop 4927, 14 June 1978 (DNA, CANB, NSW); top of Jim Jim Falls, Dunlop 5660, 30 Jan 1981 (DNA, BRI, CANB, MEL, NSW); Upper Goomadeer River, Dunlop 7232, 1 Nov 1987 (DNA, BRI, MEL, NSW); Twin Falls, about 200 m back along creek above falls, Hill 903, 16 July 1984 (NSW); Arnhemland Plateau, Lazarides 7546, 6 July 1972 (CANB, BRI, DNA, K, L, NSW, US); Site 64, 14.5 km NE of Jabiru East, Lazarides 9010, 26 May 1980 (CANB, NSW); 1 km E of Mt Gilruth, Olsen 2704, 2705, 5 June 1976 (NSW).

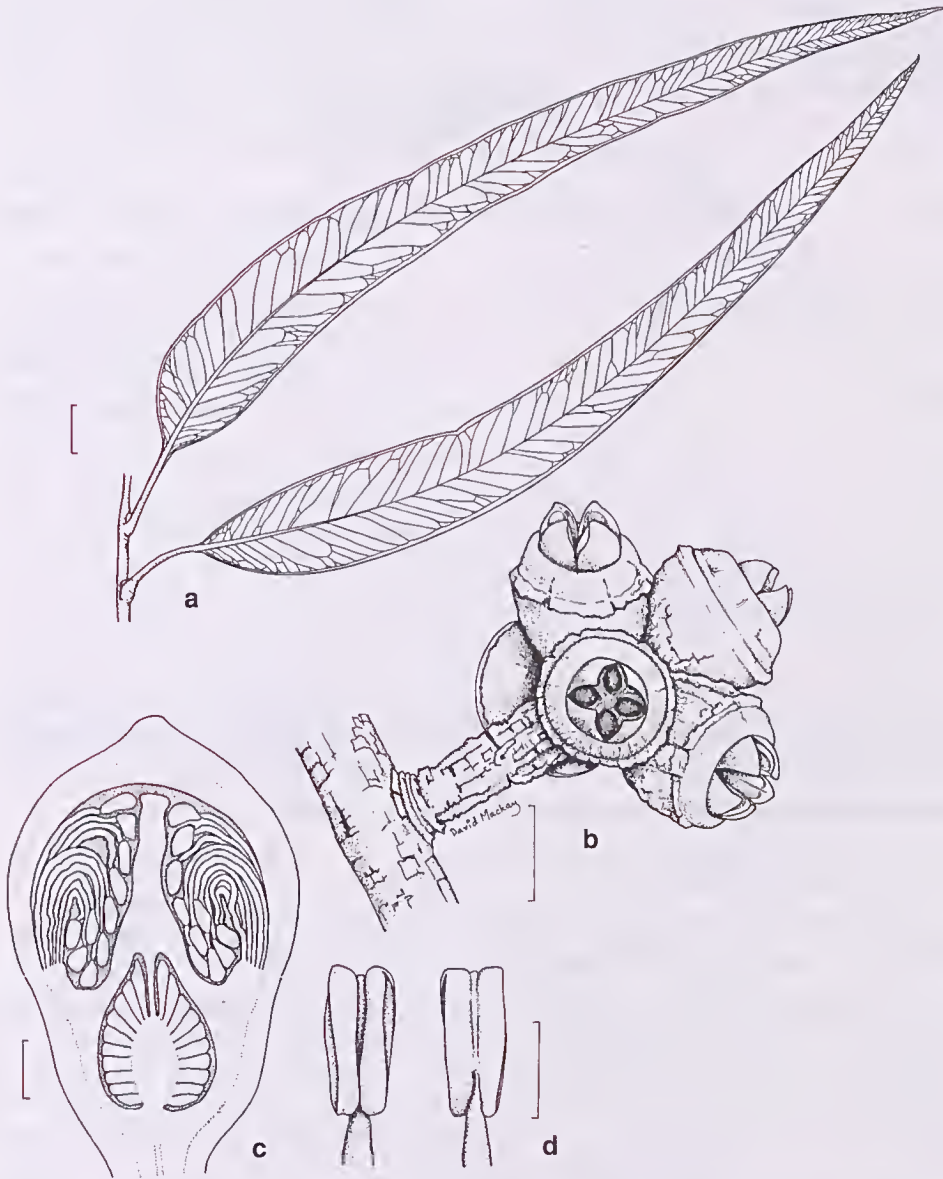


Fig. 6. *E. glomericassis*. **a**, adult leaves; **b**, infructescence and fruits; **c**, transverse section of bud; **d**, anther. (**a**, **b** from *Brooker 5358*; **c**, **d** from *Dunlop 5660*). Scale bar: **a** = 10 mm; **b** = 5 mm; **c** = 1 mm; **d** = 0.5 mm.

Series *Brevifoliae*

Bark wholly smooth, shed regularly in small thin scales, trunks usually at first salmon or orange, becoming 'powdery' white or silver. Juvenile leaves becoming disjunct very early, ovate to orbicular, petiolate. Outer calyptra shed early in development. Inner calyptra hemispherical to conical, not thickened. Stamens irregularly flexed in bud. Nectary disc absent in bud, narrowed in fruit. Valves thin. Seeds rounded to elliptical, distinctly regularly shallowly reticulate, yellow-brown.

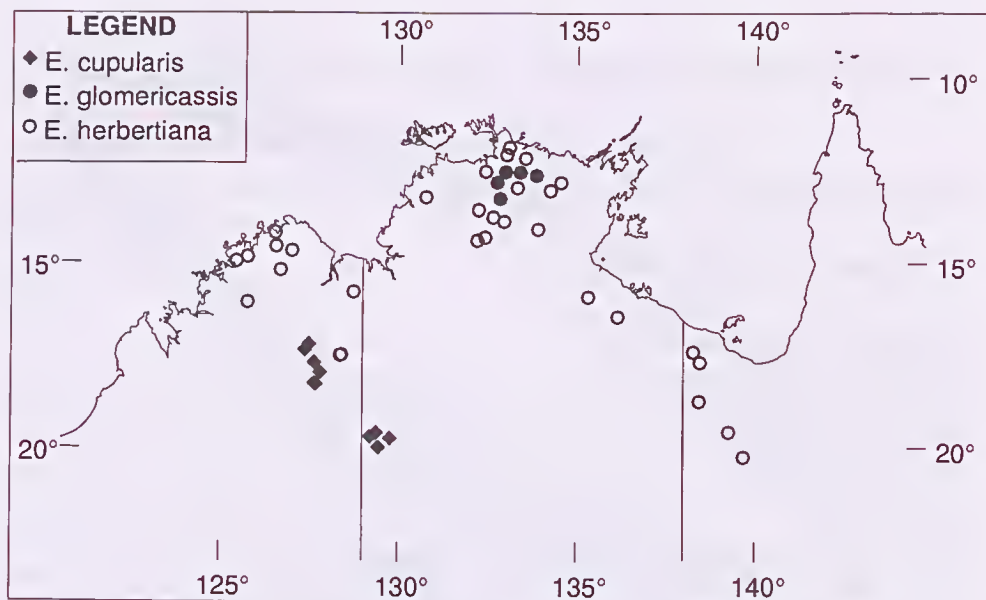


Fig. 7. Distribution of *E. cupularis*, *E. glomericassis*, *E. herbertiana*.

A series of six close species, distributed almost entirely within savanna woodland country of the monsoon tropics of Western Australia and the Northern Territory (Figs. 11 & 13). See Brooker and Kleinig (1994) for keys to species.

5. *Eucalyptus kenneallyi* K.D. Hill & L.A.S. Johnson, sp. nov.

Ab *E. rupestri* distinguitur: folia latiora breviora; ab *E. umbrawarrense* distinguitur: folia non nitentia et latiora.

Type: Western Australia: Storr Island, between Doubtful Bay and George Water, Kimberley Coast, K. Keuneally 11083, 17 July 1990 (holo NSW; iso PERTH).

Tree to 8 m tall. Bark smooth throughout, white to grey, brown or pink, shedding in large plates or flakes. Intermediate leaves becoming disjunct early, lanceolate to ovate, dull grey green, petiolate. Adult leaves disjunct, narrow lanceolate to lanceolate, not falcate, acuminate, basally tapered, dull, green to grey-green, chartaceous, concolorous, 50–110 mm long, 7–18 mm wide; petioles terete, 13–25 mm long; lateral veins obscure, acute, moderately spaced, regular; reticulum complete; intramarginal vein obscure or confluent with margin, continuous, 0–1 mm from margin. Inflorescence simple, axillary; umbellasters 7-flowered. Peduncles terete, 3–5 mm long. Pedicels terete, 1–2 mm long. Buds ovoid to clavate, not glaucous or pruinose, 6–7 mm long, 2.5–3 mm diam.; calyx calyptrate; shedding early; corolla calyptrate, free from calyx; calyptra conical, smooth, about $\frac{1}{2}$ as long as hypanthium, as wide as or slightly wider than hypanthium; hypanthium smooth. Flowers white or cream, all stamens fertile, filaments irregularly flexed in bud, anthers versatile, oblong, dehiscing by parallel slits; style base not sunken. Fruits cylindrical, pedicellate, 3-locular, smooth, 4–5 mm long, 3–3.5 mm diam.; calyptra scar flat, 0.2 mm wide; stemonophore depressed, 0.2 mm wide; disc depressed, not incurved, 1–1.5 mm wide; valves enclosed, raised at 60–80° to vertically raised. Seeds regular, ovoid to globose, finely shallowly reticulate, semiglossy, pale brown, 0.5 mm long; hilum ventral. Chaff dimorphic, linear and cuboid, similar in colour to seeds.

Distinguished by the thin, narrow, dull, adult leaves and the very small fruits with a depressed disc. Most closely allied to *E. rupestris* Brooker & Done from the central Kimberley region, which is readily distinguished by the broader and shorter leaves. These two taxa form a sister group to *E. umbrawarrensii*, a Northern Territory endemic, which is distinguished by the narrow and highly glossy leaves

Distribution: Western Kimberley Region, known at present only from offshore islands (Fig. 8).

Ecology: restricted to skeletal sandy soils on hard siliceous outcrops.

Conservation status: not known (2K).

The epithet refers to Kevin Kenneally, of the Department of Conservation and Land Management, a most active and experienced investigator of many parts of the Kimberley region of Western Australia.

Other specimen examined: Western Australia: Koolan Island, Wannan 7, Jan 1974 (UNSW, NSW).

6. *Eucalyptus leucophloia* Brooker, *Nuytsia* 2(2): 112, fig. 7 (1976).

Type: Western Australia: near Rudall River (22°37'S, 122°12'E), A.S. George 10782, 22 May 1971 (holo PERTH; iso CANB, K, NSW).

Tree to 10 m tall. Bark smooth throughout, white, powdery, shedding in small dark scales. Intermediate leaves opposite, orbiculate, dull grey-green to slightly glaucous, petiolate, to 70 mm long, 50 mm wide. Adult leaves disjunct, narrow lanceolate to lanceolate, not falcate, acuminate, basally tapered, dull, green to grey-green, chartaceous, concolorous, 50–110 mm long, 8–20 mm wide; petioles terete, 13–25 mm long; lateral veins obscure, acute, moderately spaced, regular; reticulum complete; intramarginal vein obscure or confluent with margin, continuous, 0–1 mm from margin. Inflorescence simple, axillary; umbellasters 7–11-flowered. Peduncles terete, 4–10 mm long. Pedicels terete, 1–2 mm long. Buds ovoid, not glaucous or pruinose,

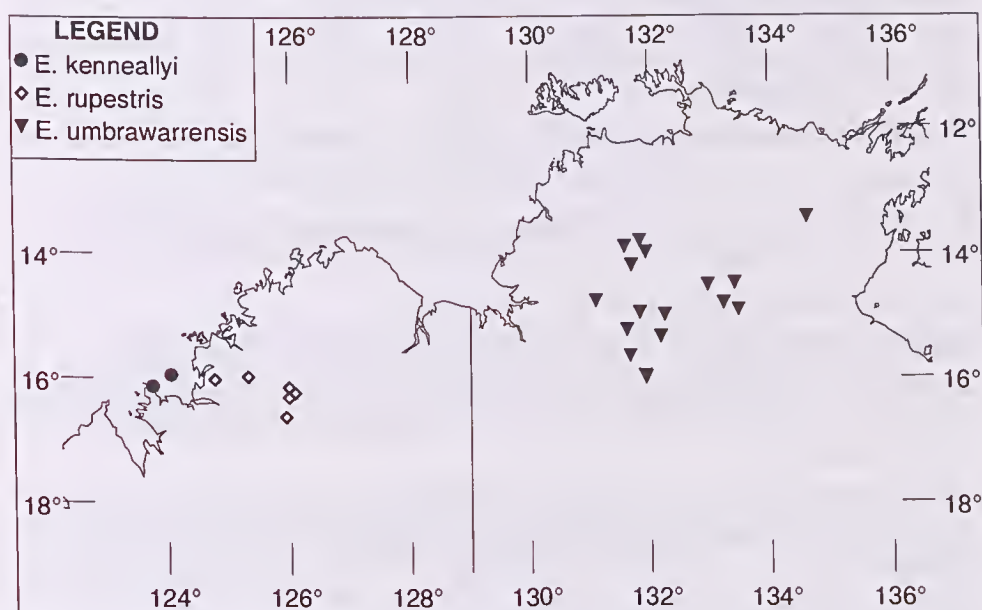


Fig. 8. Distribution of *E. kenneallyi*, *E. rupestris*, *E. umbrawarrensii*.

7–9 mm long, 3–5 mm diam.; calyx calyptrate; shedding early; corolla calyptrate, free from calyx; calyptra hemispherical to broadly conical, smooth, about as long as or slightly shorter than hypanthium, as wide as hypanthium; hypanthium smooth. Flowers white or cream, all stamens fertile, filaments irregularly flexed in bud, anthers versatile, oblong, dehiscing by parallel slits; style base not sunken. Fruits cylindrical, pedicellate, 3-locular, smooth, 5–8 mm long, 4–6 mm diam.; calyptra scar flat, 0.5 mm wide; stemonophore depressed, 0.2 mm wide; disc depressed, not incurved, 1–2 mm wide; valves enclosed, raised at 60–80° to vertically raised. Seeds flattened-ovoid, shallowly finely reticulate, semi-glossy, yellow-brown, c. 1 mm long; hilum ventral. Chaff dimorphic, linear and cuboid, similar in colour to seeds. (Fig. 9).

Two allopatric subspecies may be recognised on differences in fruit morphology.

- 1 Valves mostly enclosed 6A. subsp. *leucophloia*
 1* Valves prominently exerted 6B. subsp. *euroa*

6A. *Eucalyptus leucophloia* Brooker subsp. *leucophloia*

Distribution: restricted to the Pilbara Region of Western Australia (Fig. 10).

Ecology: widespread and common on shallower sandy soils on sandstone, usually on rises and sloping sites.

Hybrids have been recorded with *E. trivalvis* Blakely.

Conservation status: Not considered to be at risk.

Selected specimens (from 16 examined): Western Australia: Radio Hill, Paraburdoo (Paraburdoo is c. 60 km S of Tom Price), *Boomsma* 657, 10 July 1980 (AD, NSW); Dale's Gorge, Hamersley Range, SE of Wittenoom, *Briggs* 3609, 15 June 1970 (NSW); Millstream, 90 miles [144 km] NW of Wittenoom, *Brooker* 2079, 24 Sep 1969 (PERTH, NSW); 54 miles [86.4 km] N of Shepherds Roadhouse towards Roy Hill, *Brooker* 4555, 21 Apr 1974 (CANB, NSW); Shovelanna Creek rd, E of Newman, *Brooker* 8191, 4 July 1983 (CANB, NSW); At Red Gorge, between Tom Price and Wittenoom, 18 km S of Wittenoom, in Hamersley National Park, *Croat* 52273A, 6 Aug 1981 (MO, NSW); Wittenoom [Wittenoom] Gorge, above the old asbestos mine, *Croat* 52280A, 6 Aug 1981 (MO, NSW); Wittenoom Gorge, Hamersley Ranges, *Johnson* 2124, 28 Aug 1967 (NSW); Mt Florence [Florence] near Roebourne, *McVicar* 1819, 24 Aug 1922 (NSW); Tributary of Watrara Creek, *Maslin* 2068, 3 Sep 1971 (PERTH, NSW).

6B. *Eucalyptus leucophloia* Brooker subsp. *euroa* L.A.S. Johnson & K.D. Hill, subsp. nov.

Ab subspecie *leucophloia* distinguitur: valvae manifeste exsertae.

Type: Northern Territory: 34 km S of Macarthur R crossing on Tablelands Highway, *K.D. Hill* 1023, L.A.S. Johnson & D. Benson, 6 Aug 1984 (holo NSW; iso CANB, DNA, PERTH).

[*E. leucophloia* subsp. QQ Brooker & Kleinig 1994)]

Readily distinguished by the steeply raised and prominently exerted valves.

Distribution: across the drier monsoon tropics of the Northern Territory and Queensland, from Top Springs east to Cloncurry, and from Daly Waters south to Wauchope (Fig. 10).

Ecology: widespread in open savanna woodlands on shallow sandy soils on sandstone.

Some intergrades with *E. brevifolia* occur to the west of Top Springs in the Northern Territory.

Conservation status: not considered to be at risk.

The epithet is from the Latin *eurous*, eastern, referring to its occurrence in the eastern part of the species range.

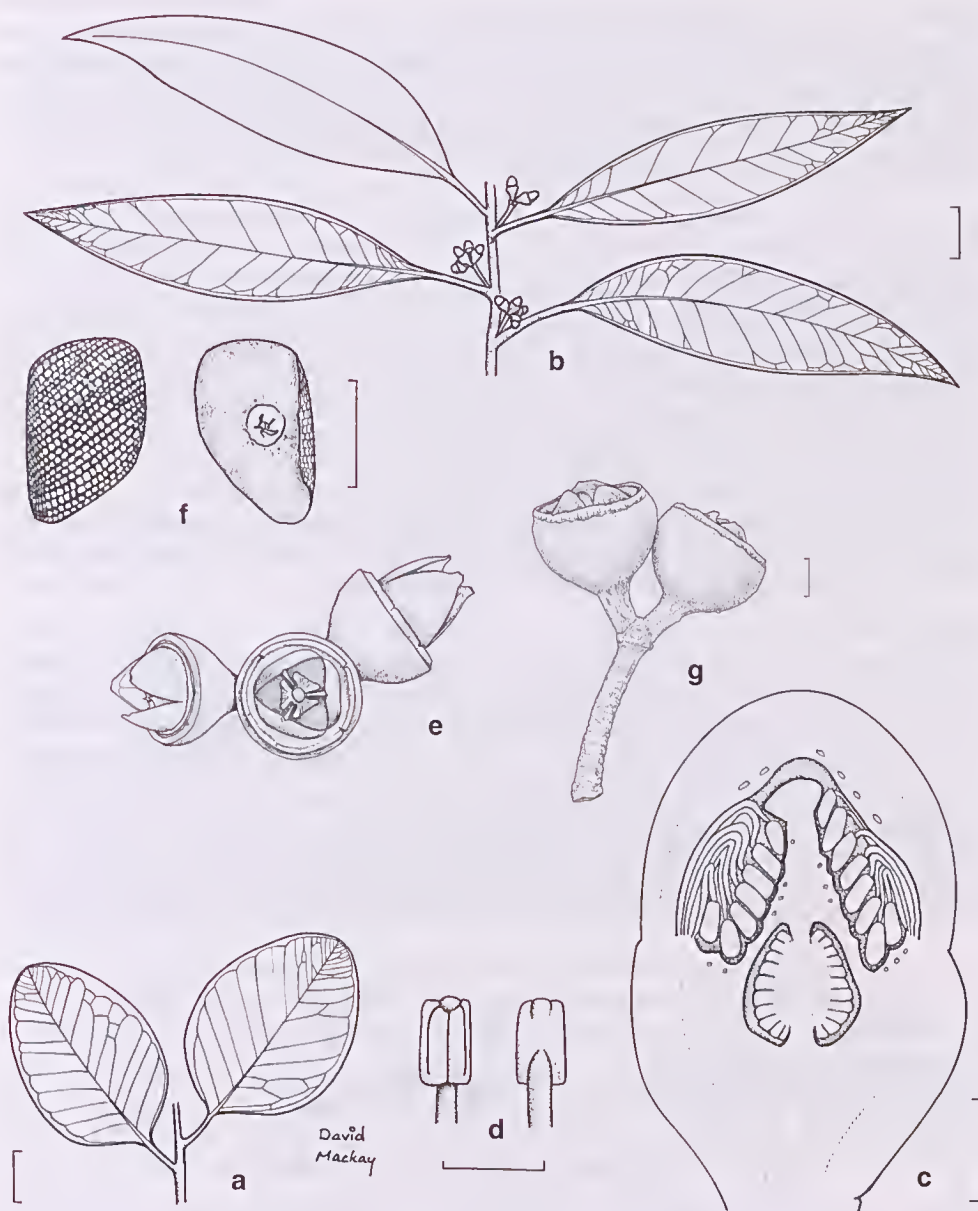


Fig. 9. *E. leucophloia* subsp. *euroa*. a, juvenile leaves; b, adult leaves, inflorescences and buds; c, transverse section of bud; d, anther; e, fruits; f, seed. *E. leucophloia* subsp. *leucophloia*. g, infructescence and fruits. (a from Hill 1023; b, c, d from NSW 132433; e, f from Hill 889; g from Croat 52273A). Scale bar: a, b = 10 mm; e, g = 2 mm; c, f = 1 mm; d = 0.5 mm.

Selected specimens (from 63 examined): Queensland: Alexander River Crossing on the Cloncurry/Burketown rd, *Carolinii* 8848, 24 Apr 1974 (SYD, NSW); 60.4 km from Adel's Grove, towards Gregory Downs, 32.1 km W of Gregory River, *Dalliston* HC313, 6 Aug 1987 (BRI, NSW); 11.7 km N of Daly Waters turn off on Stuart Highway, *Hill* 889, *Johuson & Benson*, 13 July 1984 (NSW); 60.9 km N of Burke and Wills roadhouse on Normanton rd, *Hill* 1047 & *Johnson*, 9 Aug 1984 (NSW); 10 miles [16 km] NW of Cloncurry Township, *Lazarides* 4310, 11 Mar 1954 (CANB, NSW); 40 km W of Stuart Highway on rd to Top Springs, *leg. ign.* NSW 304159, 1 July 1978 (NSW);

Camooweal Caves National Park, *McDonald* CC9, 12 Aug 1987 (BRI, NSW); c. 3 km SE of 'Wernadinga' Station, *Pullen* 9013, 2 May 1974 (CANB, NSW); 105.4 km W of Normanton on Burketown rd, *Puttock* 12584 & *St George*, 11 Nov 1982 (UNSW, CANB, DNA, NSW, QRS); 64 miles [102 km] SE of Burketown Township, *Speck* 4775, 25 July 1954 (CANB, NSW); Spring Creek 27 km N Mt Isa on Camooweal rd, *Turner* 62 & *Connell*, 10 Aug 1977 (CANB, BRI, DNA, MEL, NSW); Mica Creek 15 km S Mt Isa, *Turner* 66, 11 Aug 1977 (CANB, BRI, DNA, MEL, NSW); Lawn Hill, 'Cascade Track', *Williams* 84101, 15 Aug 1984 (BRI, NSW).

Northern Territory: Mt Isa turn-off from Stuart Highway, 622 miles [1001 km] S of Darwin, *Beaglehole* 10703, 16 July 1965 (MEL, CANB, DNA, NSW); 3.3 km N of Tennant Creek, *Brooker* 9973, 22 June 1988 (CANB, NSW); 15 miles [24 km] W of Wollongorang on road to Calvert hills, *Carolin* 9224, 12 May 1974 (SYD, NSW); Devil's Marbles, *Chippendale*, 28 Mar 1956 (DNA, NSW); 31.2 miles [50 km] SE of Top Springs store, *Chippendale & Johnson*, 4 Oct 1957 (DNA, NSW); Benzers Springs, *Forde* 230, 5 July 1956 (DNA, NSW); 5 km along road from Barkly Tableland Highway to Kilgour Gorge, *Halford* 8458, 19 May 1984 (DNA, DNA, NSW); 3.2 km S of Old Highland Plains Homestead, *Henry* 247, 26 July 1971 (DNA, NSW); 2.9 km N of Wauchope on Stuart Highway, *Hill* 876, *Johnson & Benson*, 12 July 1984 (NSW, CANB, DNA, PERTH); 61 miles [98 km] S Tennant Creek, *Newtown*, 16 Aug 1963 (DNA, NSW); 47 miles [75 km] E 3 Way Road House, *Nicholls* 588, 30 June 1967 (DNA, NSW); 63 miles [101 km] W of Frewena, *Olsen* 454, 1 July 1967 (NSW); 20 miles [32 km] SSE of Willeroo Station, *Perry* 2846, 30 May 1952 (CANB, NSW); Sunday Creek/Kalala Boundary, *Sivertsen* 947, 18 Aug 1984 (DNA, CANB, DNA, MEL, NSW); The Pebbles, 7 km W of Stuart Highway, c. 17 km NNW of Tennant Creek, *Wilson* 4539, 19 Apr 1983 (NSW).

Section *Adnataria*

Bark smooth or partly or fully persistent, shortly fibrous and flaky ('box'), or $\pm$ corky, $\pm$ kino-impregnated ('ironbark'). Pith glands present or absent. Cotyledons rounded or shallowly obreniform. Seedling leaves petiolate, opposite for few, rarely many nodes. Inflorescences sometimes simple, more often compounded with aggregations of unit umbellasters on short, leafless lateral or apparently terminal shoots (pseudoterminal). Compounded inflorescences usually do not continue vegetative growth on the same axis. Calycine calyptra shed early or persisting to anthesis, $\pm$ free from corolline calyptra; or fused to corolline calyptra. Filaments irregularly flexed or inflexed in bud, rarely erect (*E. fibrosa*). Anthers adnate, basifixed, opening by slits or pores.

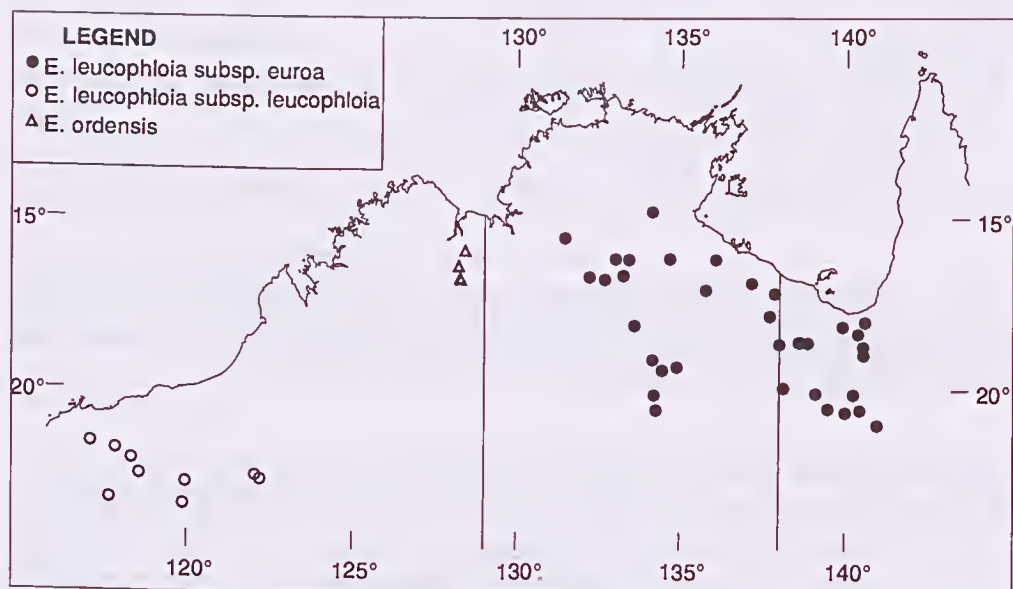


Fig. 10. Distribution of *E. leucophloia* subsp. *leucophloia*, subsp. *euroa*, *E. ordensis*.

Section *Adnataria* is a large and widespread group, occurring through all of Australia except Tasmania and the far south-west of Western Australia. The group is probably monophyletic, defined by the adnate anthers and petiolate early seedling leaves. Maximum diversity is reached in eastern Australia, with the greatest of infrasectional variety. A total of about 125 species in about 14 series can be recognised; only series *Oliganthae* being discussed here. The nature and definition of several of the possible series requires further study, and no key to the series is presented.

Series *Oliganthae*

Bark persistent, shortly fibrous and flaky ('box'), sometimes shedding on branches or throughout in subseries *Microthecosae*. Seedling leaves petiolate, opposite for few nodes (many in subseries *Pruinososae*). Adult leaves similifacial, densely regularly reticulate, lateral veins regular, at 40–60° to midrib. Pith glands absent. Inflorescences axillary or on leafless lateral or apparently terminal shoots (pseudoterminal), compounded with aggregations of unit 7-flowered umbellasters; or irregular in subseries *Microthecosae* (units are not regularly umbelliform, but have varying degrees of internode development). Calycine calyptra free from corolla, shed before anthesis. Stamens all fertile, filaments irregularly flexed in bud. Anthers adnate, globular to oblong, opening by broad lateral pores or short slits. Fruit persistent or dehiscing immediately on maturing. Seeds elliptical, shallowly reticulate; hilum ventral.

Defined within the section by the regular leaf venation, the free calycine calyptra shedding before anthesis, the absence of staminodes, and the irregularly flexed filaments with more or less globose anthers. These characters are probably all plesiomorphic within *Adnataria*, but the *Oliganthae* also appear to share a common biogeographic history.

Series *Oliganthae* was first recognised as a distinct taxonomic group in 1971 (Pryor & Johnson 1971). The first taxa in the group to be described were *E. oligantha* and *E. pruinosa*, named by Schauer (1843). These were followed by *E. leptophleba*, *E. microtheca*, *E. patellaris* and *E. spodophylla* (a later synonym of *E. pruinosa*), named by Mueller (1859).

Bentham (1867) recognised five species, placing them in series *Porantherae* (*E. pruinosa* and *E. oligantha*), series *Micrantherae* (*E. microtheca*, mistakenly as *E. brachypoda*, and *E. leptophleba*), and series *Normales* subseries *Subexsertae* (*E. patellaris*).

Species of this group were included in anther series *Porantheroideae* by Maiden (Crit. Revis. *Eucalyptus* 1903–1933, 6: 529), together with species from many other groups. Maiden later (Crit. Revis. *Eucalyptus* 1903–1933, 7: 121) placed these species in seed series *Striolatae*, again with taxa from very many other groups.

Blakely (1934) recognised 14 species, which he placed in section *Macrantherae*, series *Paniculatae* subseries *Oliganthae* (*E. argillacea*), section *Porantheroideae* series *Buxales* subseries *Subplatyphyllae*, *Megaphyllae*, *Boreales* and *Protrusae* (most species), and series *Siderophloiae* subseries *Jugatae* (*E. pruinosa*).

Blake (1953) recognised eight species in the Northern Territory, placing seven of them (along with *E. normantonensis* Maiden & Cabbage) in series *Buxales*, and the eighth with the ironbarks in series *Siderophloiae* (*E. pruinosa*).

Pryor and Johnson (1971) recognised a series *Oliganthae* with ten species (including *E. rummeryi* Maiden, now excluded, and not including *E. pruinosa*). This series was included in the wider group of boxes and ironbarks, section *Adnataria* in subgenus *Symphomyrtus*. We later revised the circumscription of the *Oliganthae* to exclude *E. rummeryi* and include *E. pruinosa* (in lists privately circulated to some eucalypt workers).

Chippendale (1988) adopted the series name *Striolatae* from Maiden, but with our modified circumscription following Pryor and Johnson, and included 14 species. Brooker (2000) coined the superfluous name *Aquiloniares* for essentially the same group.

We now recognise 32 species in this group, falling into eight subgroups or subseries (Table 5, and see key below). Most species occur in areas which have until recently been poorly collected, and confusion has surrounded species determination and nomenclature. All species except some of the *E. coolabah* Blakely & Jacobs group are tropical in occurrence (Hill & Johnson 1994). Members of this series may be locally abundant, but tend not to dominate large tracts of country in the manner of, for example, the related *E. albens* Benth. in New South Wales.

Table 5. A classification of the tropical boxes, Section Adnataria, series Oliganthae.

Section Adnataria

Series Oliganthae

Subseries Leptophlebosae

E. leptophleba

E. patellaris

Subseries Oliganthosae

E. oligantha

subsp. *oligantha*

subsp. *modica*

E. fitzgeraldii

E. koolpinensis

Subseries Tectificosae

E. tectifica

E. costuligera

Subseries Chlorophyllosae

E. chlorophylla

Subseries Argillaceosae

E. epruinata

E. microneura

E. tropica

E. leucophylla

E. limitaris

E. tephrodes

E. argillacea

E. xerothermica

Subseries Distantosae

E. distans

E. obconica

Subseries Microthecosae

E. acroleuca

E. microtheca

E. cyanoclada

E. barklyensis

E. gymnoteles

E. helenae

E. coolabah

subsp. *excerata*

subsp. *coolabah*

subsp. *arida*

E. victrix

Subseries Pruinososae

E. pruinosa

subsp. *tenuata*

subsp. *pruinosa*

Key to the subseries

- 1 Fruits persistent, more or less woody
- 2 Adult leaves disjunct, petiolate
- 3 Adult leaves ovate to orbiculate Subseries Oliganthosae
- 3* Adult leaves narrowly to broadly lanceolate
- 4 Adult leaves glossy
- 5 Fruits large, with thick valves Subseries Leptophlebosae
- 5* Fruits small, with thin valves Subseries Chlorophyllosae
- 4* Adult leaves dull

- 6 Leaves more or less coriaceous, not deciduous Subseries **Argillaceosae**
- 6* Leaves chartaceous, mostly deciduous in dry season
 Subseries **Distantosae**
- 2* Adult leaves opposite, sessile Subseries **Pruinososae**
- 1* Fruits dehiscing immediately upon maturity, more or less chartaceous
- 7 Inflorescence units regularly umbelliform Subseries **Tectificosae**
- 7* Inflorescence units not regularly umbelliform Subseries **Microthecosae**
- Subseries **Oliganthosae**

Bark fully persistent. Adult leaves ovate to orbiculate, petiolate. Fruit persistent. Seeds dark grey-brown or charcoal to black.

A subseries of three species occurring in the north of the Northern Territory and the Kimberley region of Western Australia.

7. *Eucalyptus oligantha* Schauer, in Walpers, *Repert. Bot. Syst.* 2: 926 (1843).

Type: Northern Territory: Copeland Island, Mountnorris Bay, A. Cunningham 250, 12 Apr 1818 (lecto (here designated) BM; isolecto CANB, K, NSW). Cited as: 'A. Cunn. Herb. no. 250/1818.' It is unclear as to where the primary set of specimens studied by Schauer may have been, and the BM specimen is hence here designated the lectotype since the BM was the primary repository and source for the Cunningham collections.

= *E. hillii* Maiden, J. & *Proc. Roy. Soc. New South Wales* 53: 63 (1919).

Type: Northern Territory: Bathurst Island, G.F. Hill 468, 6 Nov 1916 (holo NSW).

Included in *E. oligantha* by Blake (1953).

= *E. hillii* Maiden var. *alleniana* Blakely & Jacobs in Blakely, *Key Eucalypts*: 239 (1934).

Type: Northern Territory: near Stapleton, M.R. Jacobs 58, 12 July 1935 (holo NSW 10054).

Included in *E. oligantha* by Blake (1953).

Tree to 15 m tall. Bark persistent throughout, pale grey, shortly fibrous-flaky. Juvenile leaves disjunct early, petiolate, ovate to orbiculate. Adult leaves disjunct, similifacial, broadly ovate to orbiculate, semiglossy to glossy dark green, acute or obtuse, 50–150 mm long, 40–130 mm wide; petioles 25–60 mm long. Lateral veins $\pm$ closely-spaced, regular, at 40–60° to midrib; reticulum even, dense; oil glands small, dense, often difficult to see; intramarginal vein continuous, distinct, 0.5–1 mm from margin. Inflorescences compounded, pseudoterminal or lateral; unit umbellasters 3–7-flowered. Peduncles terete, 4–14 mm long. Pedicels terete, 2–11 mm long. Mature buds ovoid to clavate, apiculate, smooth, 6–9 mm long, 3–5 mm diam. Calyptra hemispherical to conical, sometimes apiculate, $\sim$ 1 times as long as hypanthium. Fruit cylindrical to cup-shaped, smooth, 3–4-locular, 5–11 mm long, 5–9 mm diam.; calyptra scar and stemonophore flat or somewhat depressed, c. 0.5 mm wide; disc vertically depressed, 1–2 mm wide; Valves broadly triangular, obtuse, basally enclosed, vertically raised with tips at rim level to distinctly exerted.

Two subspecies may be distinguished on regional differences in leaf, bud and fruit size.

- 1 Fruit large (6–11 $\times$ 6–9 mm) **8A. subsp. *oligantha***
- 1* Fruit small (5–6 $\times$ 5–6 mm) **8B. subsp. *modica***

8A. *Eucalyptus oligantha* subsp. *oligantha*

Adult leaves 60–150 mm long, 50–130 mm wide, petioles 25–60 mm long. Peduncles 4–11 mm long. Pedicels 2–11 mm long. Buds 7–9 mm long, 4–5 mm diam. Fruits 6–11 mm long, 6–9 mm diam.

Distribution: north of Pine Creek in the Northern Territory, extending to Melville Island (Fig. 11).

Ecology: a fairly localised species, usually occurring in open savanna woodlands on flat sites on alluvial sandy soils near creeks.

Hybrids are recorded with *E. tectifera* F. Muell. and *E. distans* Brooker, D. Boland & D. Kleinig.

Conservation status: widespread and locally abundant, not considered to be at risk.

Selected specimens (from 24 examined): Northern Territory: just W of Adelaide R, and Margaret R, *Blake* 16991, 13 Sep 1946 (BRI, NSW); 1 km W of Bark Hut hotel on the Arnhem Highway, *Boland & Wardman* 2110, 14 Nov 1984 (CANB, NSW); flats near Pimpingina Ck N of Paru [Melville Island], *Brooker* 3221, 29 June 1971 (CANB, NSW); Copeland Island, NW of Murganella, *Dunlop* 6936, 21 Oct 1987 (DNA, BRI, CANB, MEL, NSW); c. 20 km from Pine Ck on Jabiru rd, *Hill* 900, *Johnson & Benson*, 15 July 1984 (NSW, CANB, DNA, PERTH); Melville Island, Maclear Ck, S of Pickataramoor, *Hill* 908, 17 July 1984 (NSW); 10 km N of Bridge Ck on New Stuart Highway, *Hill* 3341, *Johnson & Stanberg*, 17 Nov 1988 (NSW); Bathurst Island, *Jacobs* 41, 1 July 1933 (NSW); 20 miles [33 km] NNE of Tipperary Homestead, *Lazarides* 6659, 19 July 1961 (CANB, BRI, NSW); Coomalie Ck, Stuart Highway, *Waterhouse & Worman* 11379, 15 Jan 1981 (UNSW, NSW).

8B. *Eucalyptus oligantha* subsp. *modica* L.A.S. Johnson & K.D. Hill, subsp. nov.

Ab subspecie *oligantha* foliis, alabastris et fructibus totis minoribus delicatioribusque distinguitur.

Type: Western Australia: 1 km E of Durack R. crossing on Gibb R rd, *K.D. Hill* 943, *L.A.S. Johnson & D. Benson*, 23 July 1984 (holo NSW; iso CANB, DNA, PERTH).

Adult leaves 50–100 mm long, 40–90 mm wide, petioles 25–45 mm long. Peduncles 5–14 mm long. Pedicels 4–7 mm long. Buds 6–8 mm long, 3–4 mm diam. Fruits 5–6 mm long, 5–6 mm diam.

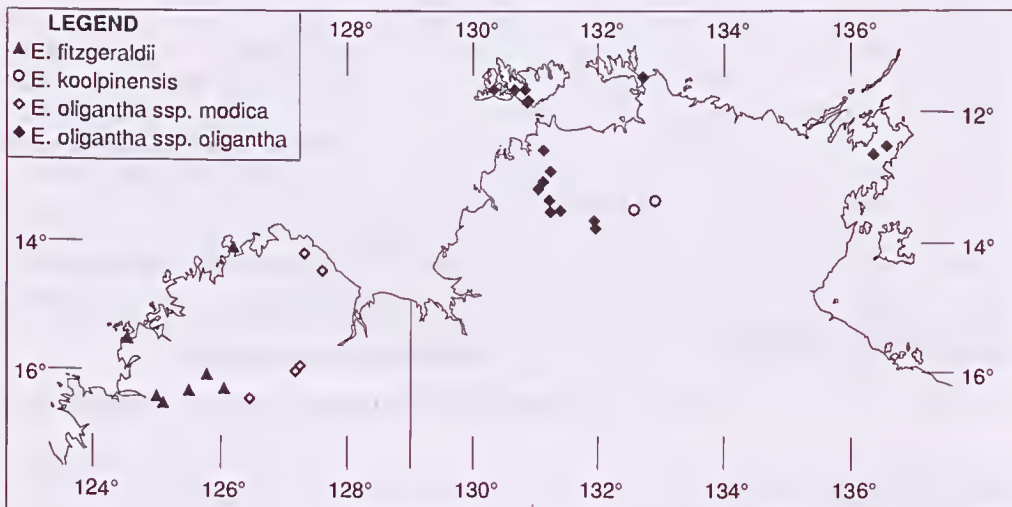


Fig. 11. Distribution of *E. fitzgeraldii*, *E. koolpinensis*, *E. oligantha* subsp. *oligantha*, subsp. *modica*.

Distinguished from the type subspecies by the smaller and more delicate leaves, buds and fruits.

Distribution: north and east of Gibb River station in Western Australia, not extending east of the Durack Range (Fig. 11).

Ecology: restricted and highly localised, usually on alluvial sandy soils near creeks.

Conservation status: although of rather restricted distribution and not abundant within its range, this species occurs in a habitat that is not significantly threatened (3R).

The epithet is from the Latin *modicus*, moderate-sized, from the smaller sizes of all parts of this subspecies in contrast to the type subspecies.

Selected specimens (from 6 examined): Western Australia: 13 km W of Berkeley R, *Brooker* 7778, 2 Nov 1982 (CANB, NSW); 7.2 km W of King George R crossing on track to Carson R., *Hill* 953, *Johnson & Benson*, 25 July 1984 (NSW); 'Gibb River' Station near Homestead, *Johnson* 2090, 26 Aug 1967 (NSW); 50 miles [82 km] NNW of Gibb R. Station, *Speck* 4977, 10 Sep 1954 (CANB, NSW).

Subseries *Tectificosae*

Bark fully persistent. Adult leaves lanceolate. Fruit chartaceous, dehiscing immediately on maturing. Seeds grey-brown to dark grey-brown.

A subseries of two species occurring in grassy savanna country in north-western Queensland and the north of the Northern Territory and Western Australia.

Key to species

- 1 Fruits smooth, 4–6 mm long, 4–5 mm diam. *E. tectifera*
- 1* Fruits ribbed, 6–8 mm long, 5–7 mm diam. *E. costuligera*

9. *Eucalyptus costuligera* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. tectifera* distinguitur: folia alabastraque glauca, alabastra fructusque longiores et costati. Habitat sola sicca, saxosa aliquantum elevata.

Type: Western Australia: 60 km E of Gibb River to Kalumburu road on Wyndham road (16°20'S, 126°55'E), *M.I.H. Brooker* 7780, 3 Nov 1982 (holo NSW; iso CANB, PERTH).

Tree to 10 m tall. Bark persistent throughout, pale grey, shortly fibrous-flaky (box). Adult leaves disjunct, similifacial, lanceolate, obtuse, 70–150 mm long, 17–30 mm wide; petioles to 22 mm long; lateral veins $\pm$ closely-spaced, regular, at 40–60° to midrib; reticulum even, dense; oil glands small, dense; intramarginal vein continuous, distinct, <0.5 mm from margin or at margin. Inflorescences compounded, pseudoterminal or axillary; unit umbellasters 1–7-flowered, somewhat irregular. Peduncles terete, 1–15 mm long. Pedicels terete or $\pm$ ribbed, 2–6 mm long. Mature buds clavate, apiculate, regularly shallowly ribbed; c. 7 mm long, c. 4 mm diam.; calyptra broadly hemispherical, apiculate to rostrate, c. 1/2 as long as hypanthium. Fruit cylindrical to cup-shaped or pyriform, apically constricted, $\pm$ chartaceous, often regularly shallowly ribbed, 3–4-locular, 6–8 mm long, 5–7 mm diam., deciduous at maturity; calyptra scar and stemonophore flat or somewhat depressed, <0.5 mm wide; disc vertically depressed, 1–2 mm wide; valves broadly triangular, obtuse, wholly enclosed, vertically raised, $\pm$ chartaceous. (Fig. 12).

Eucalyptus costuligera differs from *E. tectifera* F. Muell. in the more coriaceous, glaucous leaves and buds, the longer, ribbed buds and fruit, and the differing habitat, on elevated, dry, shallow, stony soils.

Distribution: Western Australia: central north-east Kimberley region (Fig. 13).

Ecology: locally abundant but apparently restricted on dry, elevated skeletal soils over sedimentary rocks, with *Corymbia grandifolia* (R. Br. ex Benth.) K.D. Hill & L.A.S. Johnson, *Eucalyptus obconica* Brooker & Kleinig and *E. jensenii* Maiden.

Conservation status: widespread and locally abundant, not considered to be at risk.

The epithet is from the Latin *costa*, a vein or rib, with the diminutive suffix *-ula*, *-ulum*, together with the suffix *-ger*, bearing or carrying, referring to the distinctively finely ribbed fruits.

Specimens examined: Western Australia: 11 km W of Durack R crossing on Gibb R. rd, Hill 944, Johnson & Benson, 23 July 1984 (NSW); 12.7 km W of Durack R on Gibb R. Rd, Hill 3374, Johnson & Stanberg, 19 Nov 1988 (NSW, CANB, PERTH); 82 miles [c. 133 km] SW of Wyndham Township, Perry 3087, 29 Aug 1952 (CANB, NSW).

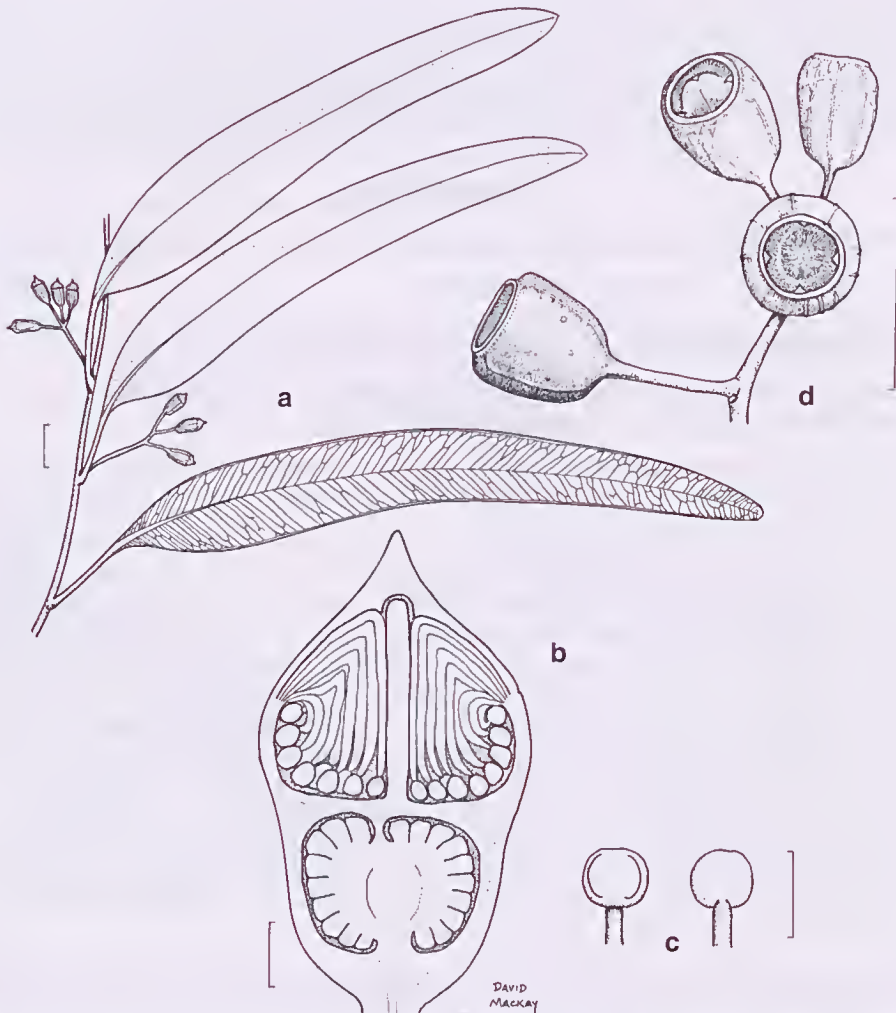


Fig. 12. *E. costuligera*. a, adult leaves, inflorescences and buds; b, transverse section of bud; c, anther; d, fruits. (from Brooker 7780). Scale bar: a, d = 10 mm; b = 1 mm; c = 0.5 mm.

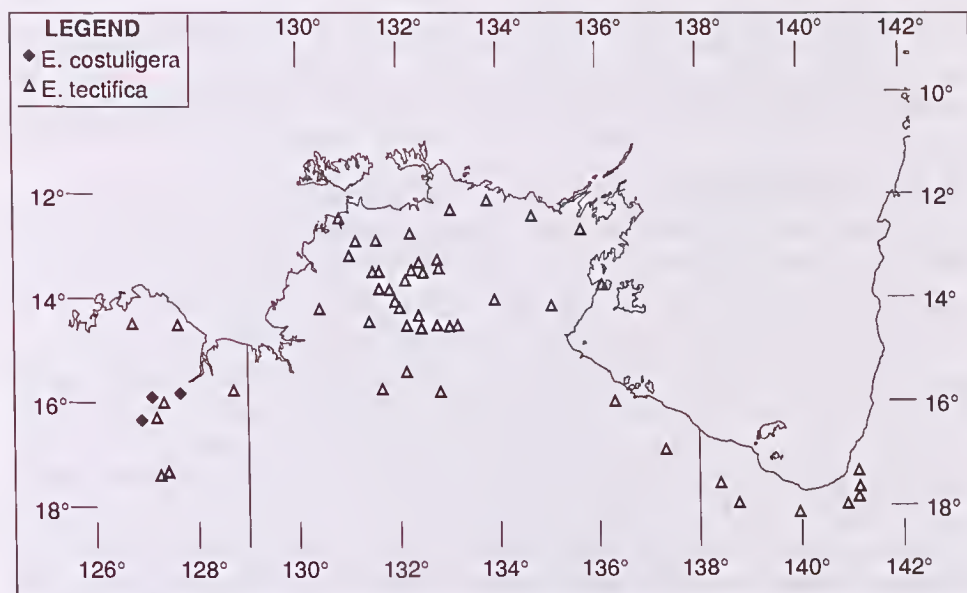


Fig. 13. Distribution of *E. costuligera*, *E. tectifica*.

Subseries Argillaceosae

Bark fully persistent. Adult leaves dull, narrow-lanceolate to narrow-ovate. Fruit small to large, persistent. Seeds dark grey-brown or charcoal to black.

A subseries generally occurring in the drier parts of the monsoon savanna region, extending onto drier sites in some wetter areas. The nine species are closely related, and occur in a geographic replacement pattern with some overlap, where ecological segregation is evident.

Key to species (after Brooker & Kleinig 1994)

- 1 Twigs, leaves and buds glaucous
 - 2 Qld species
 - 3 Fruits cup-shaped *E. tropica*
 - 3* Fruits obconical *E. microneura*
 - 2* NT and WA species
 - 4 Fruits cup-shaped *E. tephrodes*
 - 4* Fruits obconical *E. argillacea*
- 1* Twigs, leaves and buds not glaucous
 - 5 Qld species
 - 6 Fruits cup-shaped *E. epruinata*
 - 6* Fruits obconical *E. leucophylla*
 - 5* NT and WA species

- 7 Kimberley and NT; leaves thin (0.28–0.38 mm when dry); peduncles and pedicels long (6–23 and 2–9 mm) *E. limitaris*
- 7* Pilbara; leaves thick (0.39–0.51 mm when dry); peduncles and pedicels short (2–9 and 1–3 mm) *E. xerothermica*

10. *Eucalyptus epruinata* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. microneura* et aliis speciebus affinis distinguitur: pruina absens, petioli pedunculi pedicellique graciles, fructus breves parvique valvis valde exsertis.

Type: Queensland: 7.6 km E of Croydon on Georgetown road (18°09'S, 142°12'E), K. Hill 1056 & L. Johnson, 10 Aug 1984 (holo NSW; iso BRI, CANB, K).

Tree, sometimes mallee, to 6 m tall. Bark fully persistent, grey, coarsely shortly fibrous-flaky (box). Adult leaves disjunct, similifacial, lanceolate to ovate, obtuse, 50–110 mm long, 10–35 mm wide; petioles to 22 mm long, slender; lateral veins $\pm$ closely spaced, regular, at 40–60° to midrib; reticulum even, dense; oil glands small to large, moderately spaced; intramarginal vein continuous, distinct, 0.5–2.0 mm from margin. Inflorescences compounded, pseudoterminal or axillary; unit umbellasters 3–7-flowered. Peduncles slender, terete, 5–15 mm long. Pedicels slender, terete, 2–6 mm long. Fruit cylindrical to cup-shaped, 4-locular, 4–5 mm long, 4–5 mm diam.; calyptra scar not continuous with stemonophore, flat, <0.1 mm wide; stemonophore depressed, 0.2–0.4 mm wide, with a flat, persistent staminal ring; disc flat, <0.5 mm wide, situated below the level of the staminal ring; valves broadly triangular, obtuse or acute, fully exserted, raised 45–90°, $\pm$ chartaceous. Seeds semi-glossy to dull, brownish-black, rounded, elliptical, regularly shallowly reticulate; hilum ventral. Chaff orange-brown.

E. epruinata is distinguished by the absence of glaucousness, slender petiole, peduncle and pedicel, and the small, short fruit with strongly exserted valves.

Distribution: Queensland: South western Cape York Peninsula, Croydon to Kowanyama (Fig. 14).

Ecology: locally abundant in open woodland on flat sandy clay-loam, with *E. leptophleba* F. Muell., *Corymbia polycarpa* (F. Muell.) K.D. Hill & L.A.S. Johnson, *Melaleuca viridiflora* Sol. ex Gaertner and *Petalostigma pubescens* Domin.

Conservation status: not considered to be at risk.

The epithet is from the Latin *pruinatus*, pruinose, with the Latin prefix *ex-*, *e-*, without or lacking, referring to the lack of pruinosity in contrast to its distinctly pruinose sister species *E. microneura* Maiden & Blakely.

Selected specimens (from 6 examined): Queensland: 9.4 km W of Croydon on highway, Hill 1055 & Johnson, 10 Aug 1984 (NSW); Croydon Base Camp, Speck 4753, 21 July 1954 (CANB, NSW).

11. *Eucalyptus limitaris* L.A.S. Johnson & K.D. Hill, sp. nov.

Inter subseriem *Argillaceos* distinguitur: folia relative tenuia non pruinosa; pedunculae pedicellique longi; fructus mediocres, conici vel cylindrici.

Type: Western Australia: 5 km E of Mary R crossing on Fitzroy Crossing to Halls Creek road (18°42'S, 126°54'E), K. Hill 987, L. Johnson & D. Beusou, 2 Aug 1984 (holo NSW; iso DNA, CANB, K, PERTH).

[*E. sp.* UU in part, Brooker & Kleinig 1994]

Tree or mallee to 8 m tall. Bark fully persistent, deeply fissured, grey-brown, shortly fibrous-flaky (box). Adult leaves disjunct, similifacial, dull green, narrow-lanceolate to broad-lanceolate, 90–250 mm long, 14–35 mm wide, 0.28–0.38 mm thick; petioles

12–26 mm long; lateral veins closely-spaced, regular, at 40–60° to midrib; reticulum even, dense; oil glands small, obscure; intramarginal vein continuous, distinct, <1 mm from or at margin. Inflorescences compounded, pseudoterminal or lateral; unit umbellasters 3–7-flowered. Peduncles terete, (3–)6–23 mm long. Pedicels terete or angular, thick, 2–9 mm long. Fruit conical to cup-shaped or cylindrical, 4–5-locular, 7–11 mm long, 6–8 mm diam.; calyptra scar and stemonophore raised or flat, 0.5–0.7 mm wide, often with a persistent staminal ring; disc flat to steeply depressed, 1–2 mm wide; valves broadly triangular, obtuse, basally enclosed, apically rim-level or exserted, raised at 45–90°. Seeds semiglossy to dull, brownish-black or black, rounded, elliptical, regularly shallowly reticulate; hilum ventral. Chaff mid-brown. (Fig. 15).

E. limitaris is distinguished by the relatively thin, dull green leaves with no glaucous bloom, the long pedicels and peduncles, and the large conical or cylindrical fruit.

Distribution: southern Kimberley region, from west of Fitzroy Crossing to Halls Creek, and east to west of Top Springs (Fig. 16).

Ecology: locally common but sporadic, on shallow red loam over various rock types, in open savanna shrubland, often near dry creek lines.

Pure populations occur in the west of the range around Fitzroy crossing, and again in the east towards Top Springs. Extensive breakdown occurs however with *E. teplirodes* around Halls Creek. *E. limitaris* and *E. teplirodes* display a similar extensive breakdown pattern to that seen with the *E. tropica* Cambage–*E. leucophylla* Domin, *E. xerothermica*–*E. teplirodes* and *E. epruinata*–*E. microneura* pairs. *E. limitaris* and *E. teplirodes* however show extensive pure stands of the parent species, and a degree of ecological separation

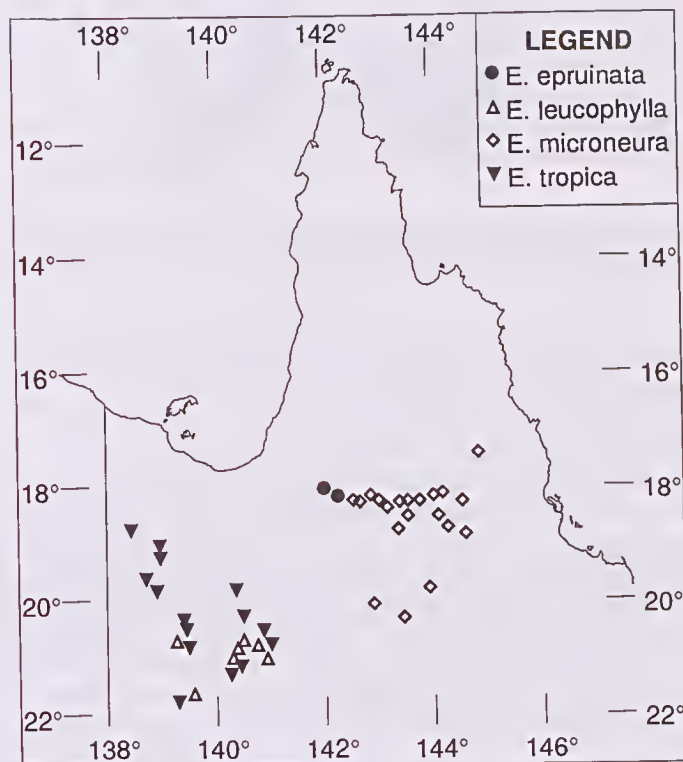


Fig. 14. Distribution of *E. epruinata*, *E. leucophylla*, *E. microneura*, *E. tropica*.

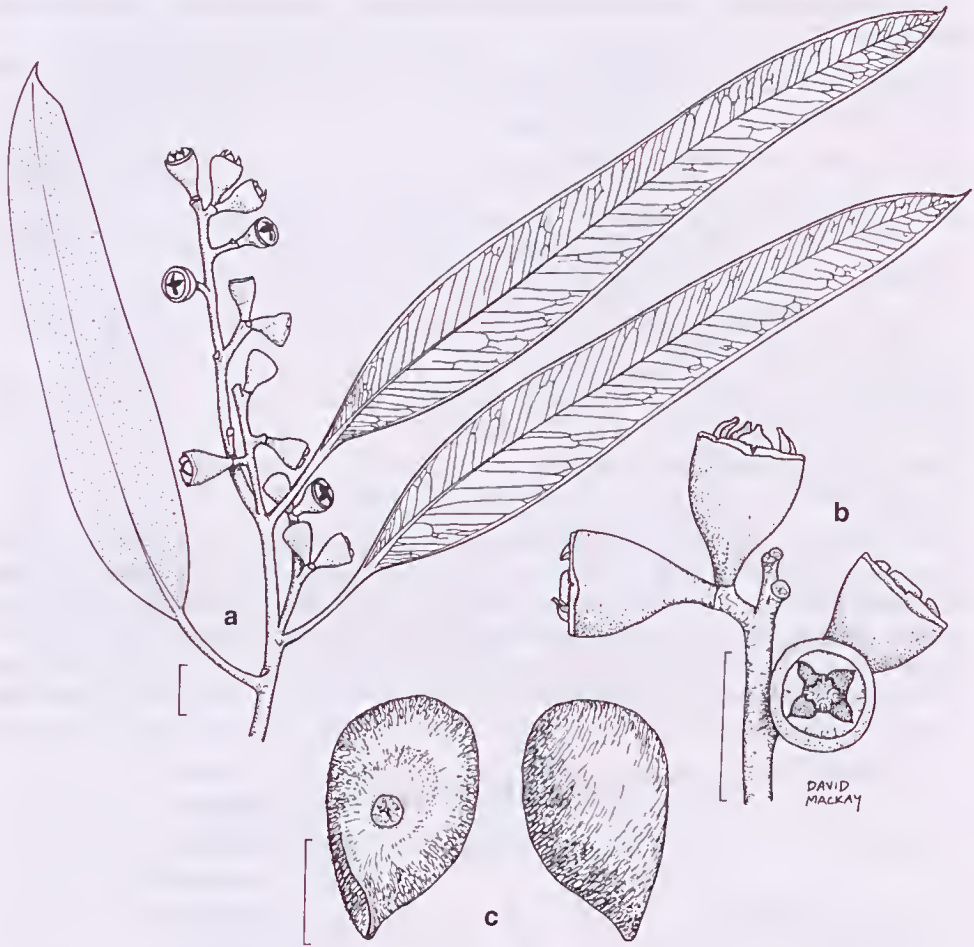


Fig. 15. *E. limitaris*. a, adult leaves, infructescences and fruits. b, fruits; c, seed. (from Hill 1987). Scale bar: a, b = 10 mm, c = 1 mm.

in the breakdown zone. Here, *E. tephrodes* or plants with a greater obvious influence of that taxon tend to favour higher ground.

Conservation status: not considered to be at risk.

The epithet is from the Latin *limes*, *limitis*, a border or boundary, in reference to the distribution across the Western Australia–Northern Territory border.

Selected specimens (from 19 examined): Northern Territory: Montejinni turnoff on Buchanan Highway, Hill 1007, Johnson & Benson, 4 Aug 1984 (NSW, CANB, DNA, PERTH); 53 miles [85 km] SE of Mistake Ck Homestead, Perry 3193, 30 Aug 1952 (CANB, NSW); Mistake Ck, Robinson 88, 26 Aug 1970 (NT, NSW). Western Australia: 35 km N of highway towards Windjana Gorge, Brooker 10127, 20 Oct 1988 (CANB, NSW); 16.5 km E of Halls Ck on Nicholson rd, Hill 999, Johnson & Benson, 3 Aug 1984 (NSW); 25.7 km E of Tunnel Ck (just E of Cajeput Ck), Hill 3443, Johnson & Stanberg, 23 Nov 1988 (NSW, CANB, PERTH); 7.7 km from Echidna Gorge to 3 Ways, Bungle Bungle NP, Hill 3501, Johnson & Stanberg, 28 Nov 1988 (NSW); 13.9 km N of RB creek on Duncan Highway, Hill 3521 & Stanberg, 30 Nov 1988 (NSW, CANB, PERTH); 27 km from Duncan Highway towards Nelson Springs, Hill 3522 & Stanberg, 30 Nov 1988 (NSW).

12. *Eucalyptus tephrodes* L.A.S. Johnson & K.D. Hill, sp. nov.

Inter subseriem *Argillaceas* distinguitur: folia magna, crassiuscula, glauca; fructus majusculi plus minusve aequidimensionales in pedicellis et pedunculis longis crassisque.

Type: Western Australia: 40.1 km from highway towards Bedford Downs, K.D. Hill 3463, L.A.S. Johnson & L. Stanberg, 25 Nov 1988 (holo NSW; iso CANB, PERTH).

[*E. sp.* UU in part, Brooker & Kleinig 1994]

Tree or sometimes mallee to 10 m tall. Bark fully persistent, grey to grey-white, shortly fibrous-flaky (box). Juvenile leaves disjunct, glaucous, ovate-lanceolate to orbicular, petiolate, to 60 mm wide, 90 mm long. Adult leaves disjunct, similifacial, glaucous, lanceolate to broad-lanceolate, acute or rounded, 70–170 mm long, 12–45 mm wide, 0.31–0.44 mm thick; petioles 12–23 mm long; lateral veins closely-spaced, regular, at 40–60° to midrib; reticulum even, dense; oil glands small, obscure; intramarginal vein continuous, distinct, <1 mm from or at margin. Inflorescences compounded, pseudoterminal or axillary; unit umbellasters 3–7-flowered. Peduncles terete, 4–12 mm long. Pedicels terete or ± flattened, 2–6 mm long. Mature buds clavate, 8–9 mm long, 4–5 mm diam.; calyptra hemispherical, shortly apiculate, c. 1/2 as long as hypanthium. Fruit cup-shaped to globular-truncate, rarely cylindrical or pyriform, 4–6-locular, 6–10 mm long, 6–11 mm diam.; calyptra scar and stemonophore flat, c. 0.5 mm wide; disc vertically depressed, 1–2 mm wide; valves broadly triangular, obtuse, deeply enclosed, tips rarely exerted, raised at 45° or more. Seeds semi-glossy to dull, brownish-black, rounded, elliptical, regularly shallowly reticulate; hilum ventral. Chaff orange-brown. (Fig. 17).

E. tephrodes is distinguished by the large, moderately thick glaucous leaves and the large more or less equidimensional fruit with long, thick pedicels and peduncles. Leaves are thicker in the north and west of the range in the Kimberley region, and also in the Pilbara region (0.36–0.44 mm), becoming thinner (0.31–0.37 mm) around Halls Creek. It is more frequently a medium-size single-trunked woodland tree than the related and partly sympatric *E. limitaris*. Both taxa however may form true mallees with extensive subterranean lignotubers.

Distribution: Western Australia, south-east Kimberley region, Halls Creek and north, with a disjunct occurrence in the eastern Pilbara region (Fig. 16).

Ecology: locally common but sporadic in open savanna woodland with *Corymbia flavescentis* K.D. Hill & L.A.S. Johnson, *E. camaldulensis* subsp. *obtusa*, *E. brevifolia* and *E. limitaris*, on more or less loamy soils on various sites from dry creek-beds to low stony hills. Quite extensive woodlands of this species occur around Bedford Downs and west of there. In the Pilbara region, this species is less common and more widely scattered, and occurs in red loam along drainage lines and dry watercourses in open flat country, associated with *E. trivalvis*, *Corymbia hamersleyana* (D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson, *E. leucophloia* subsp. *leucophloia*, *E. xerothermica* and *C. candida* K.D. Hill & L.A.S. Johnson. Intergradation with *E. xerothermica* is discussed under the latter. In areas where the two occur together, *E. tephrodes* favours flatter sites on deeper soils, with *E. xerothermica* on shallower soils on higher sites. This is in contrast to the ecological segregation between *E. limitaris* and *E. tephrodes*, where *E. tephrodes* favours higher sites. The somewhat different habitat of *E. tephrodes* in the Pilbara region compared with that in the Kimberley region suggests that some genetic differences may be present, but no clear morphological distinction can be made between the two occurrences.

Conservation status: widespread and locally abundant, not considered to be at risk.

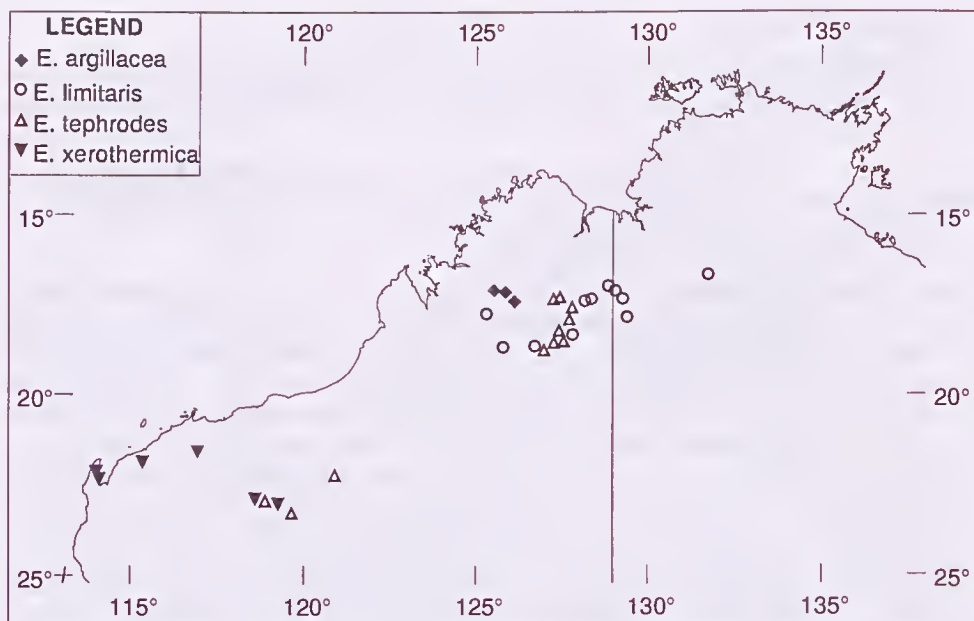


Fig. 16. Distribution of *E. argillacea*, *E. limitaris*, *E. tephrodes*, *E. xerothermica*.

The epithet is from the Greek *tephros*, ash-grey, with the Greek termination *-odes*, *-oides*, resembling, from the grey-glaucous foliage.

Selected specimens (from 21 examined): Western Australia: c. 40 km N of Halls Ck, *Beadle* 179, 22 Sep 1972 (NSW); between Turkey Creek and Halls Creek, *Brooker* 7743, 26 Oct 1982 (CANB, NSW, PERTH); c. 4 km NW of Mt Meharry on access track to Trig Point, *Hill* 483, *Johnson, Blaxell, Brooker & Edgecombe*, 1 Nov 1983 (NSW, CANB, PERTH); 118.9 km W of Newman on track to Tom Price via Mt Meharry, (22°56'S, 118°53'E), *Hill* 485, *Johnson, Blaxell, Brooker, Edgecombe*, 1 Nov 1983 (NSW, CANB, K, PERTH); 54 km SW of Halls Ck on highway, *Hill* 989, 990, *Johnson & Benson*, 2 Aug 1984 (NSW); 7.6 km from Bedford Downs towards Lansdowne, *Hill* 3470, *Johnson & Stanberg*, 25 Nov 1988 (NSW); Teronis Gorge at Chamberlain River crossing, *Hill* 3485, *Johnson & Stanberg*, 26 Nov 1988 (NSW, CANB, PERTH); 6–8 km from New Halls Ck on rd to Halls Ck, *Johnson* 2065, 25 Aug 1967 (NSW); 0.8 km NW of Bedford Downs Homestead, *Johnson* 2068, 25 Aug 1967 (NSW); 14 miles [23 km] S of Rockhole Station, *Lazarides* 3190, 23 Aug 1952 (CANB, BRI, NSW, NT, PERTH); 16 miles [25.5 km] W of Halls Ck township, *Perry* 3179, 17 Aug 1952 (CANB, BRI, K, NSW, DNA, PERTH, US).

13. *Eucalyptus xerothermica* L.A.S. Johnson & K.D. Hill, sp. nov.

Ab *E. limitari* distinguitur: folia crassiuscula; pedicellis et pedunculis brevioribus; fructus proportione latiores.

Type: Western Australia: 'Palm Pool', c. 5 km W (downstream) of Millstream Tavern (old homestead) on Fortescue River, *K.D. Hill* 430, *L.A.S. Johnson, D.F. Blaxell, M.I.H. Brooker & W. Edgecombe*, 30 Oct 1983 (holo NSW; iso CANB, PERTH).

[*E. sp.* VV Brooker & Kleinig 1994]

Tree or mallee to 6 m tall. Bark fully persistent, yellowish-grey to grey-brown, shortly fibrous-flakey (box). Adult leaves disjunct, similifacial, dull green, narrow-lanceolate to broad-lanceolate, rounded to acute, 110–230 mm long, 10–35 mm wide, 0.39–0.51 mm thick; petioles thick, 9–21 mm long; lateral veins closely-spaced, regular, at 40–60° to

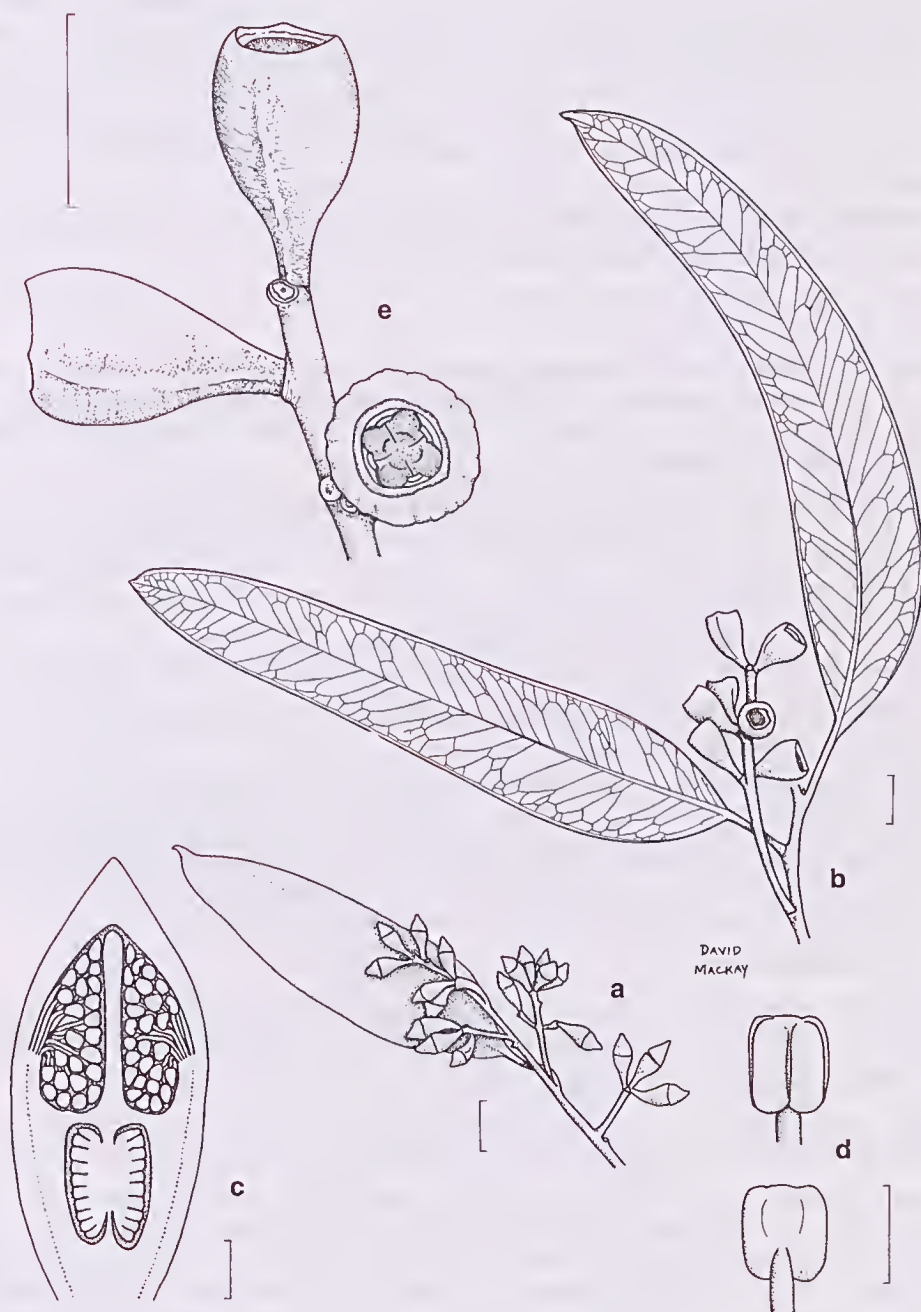


Fig. 17. *E. tephrodes*. a, adult leaves, inflorescences and buds; b, adult leaves, infructescences and fruits; c, transverse section of bud; d, anther; e, fruits. (a, c, d from Brooker 7743; b, e from Johnson 2065). Scale bar: a, b, e = 10 mm; c = 1 mm; d = 0.5 mm.

midrib; reticulum even, dense; oil glands small, obscure; intramarginal vein continuous, distinct, 0.5 mm from margin. Inflorescences simple or compounded, pseudoterminal or axillary; unit umbellasters 3–7-flowered. Peduncles thick, terete, 2–9 mm long. Pedicels thick, terete or angular, 1–3 mm long. Fruit cylindrical to cup-shaped, tapering into pedicel, 4–5-locular, 7–9 mm long, 7–10 mm diam.; calyptra scar and stemonophore flat, 0.7–1.0 mm wide; disc flat to vertically depressed, 1–2 mm wide; valves broadly triangular, obtuse or acute, basally enclosed or rim level, apically rim level or exerted, raised at 45–90°. Seeds semi-glossy to dull, brownish black, somewhat angular to rounded, elliptical, regularly shallowly reticulate; hilum ventral. Chaff brown.

E. xerothermica is nearest to *E. limitaris*, differing in the thicker leaves, generally shorter pedicels and peduncles, and proportionally broader fruits.

Distribution: Western Australia: Pilbara region, North West Cape and nearby islands (Fig. 16).

Ecology: widely scattered but local, on red, shallow loam, usually calcareous and often with calcrete, over various rock types. A component of low open savanna, associated with *E. camaldulensis* var. *obtus*, *E. victrix* L.A.S. Johnson & K.D. Hill, *Corymbia hamersleyana* and *C. candida*.

E. xerothermica and *E. tephrodes* show a pattern of intergradation similar to that of *E. limitaris* and *E. tephrodes*, discussed above under *E. limitaris*. In this case, however, *E. tephrodes* tends to occur on deeper soils on lower sites or on flatter country somewhat to the east of the range of *E. xerothermica*. Very little pure *E. tephrodes* with no *E. xerothermica* influence is known, however.

Conservation status: widespread and locally abundant, not considered to be at risk.

The epithet is from the Greek *xeros*, dry, and *thermos*, hot, referring to the hot and dry climate of the Pilbara region.

Selected specimens (from 13 examined): Western Australia: 13 miles [21 km] E of Mt Bruce in Dales Gorge, *Brooker* 2175, 29 Sep 1969 (PERTH, NSW); 58.8 km S of Exmouth on main rd, *Hill* 404, *Johnson, Blaxell, Brooker & Edgecombe*, 28 Oct 1983 (NSW); 3.5 km W of Exmouth along Charles Knife rd, 30 km S of Exmouth, *Hill* 411, *Johnson, Blaxell, Brooker & Edgecombe*, 28 Oct 1983 (NSW, CANB, PERTH); 35 km NW of Highway on Onslow rd, *Hill* 427, *Johnson, Blaxell, Brooker & Edgecombe*, 29 Oct 1983 (NSW); top of Mt Meharry, *Hill* 479, *Johnson, Blaxell, Brooker & Edgecombe*, 1 Nov 1983 (NSW).

Subseries **Pruinorosae**

Bark fully persistent, 'box'. Adult leaves opposite, ± sessile, ovate, cordate, strongly glaucous. Fruit persistent. Seeds dark grey-brown or charcoal to black.

14. Eucalyptus pruinosa Schauer, in Walpers, *Rep. Bot. Syst.* 2: 926 (1843).

Type: Queensland: Sweers, Bentinck & Allen's Is., *R. Brown & F. Bauer* 33, Nov 1802 (holo W; iso BM, E, K). Cited as: 'In Nova Hollandia fructiferam legit Ferd. Bauer!'

Tree or mallee to 6 m tall. Bark fully persistent, grey to grey-brown, shortly fibrous-flaky. Juvenile leaves opposite, at first petiolate, later sessile, ovate to elliptical. Adult leaves opposite, sessile, often amplexicaul, similifacial, dull grey-green or glaucous, ovate to elliptical, rounded to acute, 25–150 mm long, 15–90 mm wide. Inflorescences compounded, pseudoterminal; unit umbellasters 3–7-flowered. Peduncles terete, 4–25 mm long. Pedicels terete, 2–22 mm long. Buds narrowly ovoid to fusiform, often glaucous, 6–12 mm long, 3–6 mm diam.; calyptra conical and acute to hemispherical and rostrate, 1/2–1 times as long as hypanthium. Fruit cylindrical to cup-shaped, tapering into pedicel, 3–5-locular, 5–12 mm long, 4–10 mm diam.; calyptra scar and stemonophore flat, 0.7–1.0 mm wide; disc flat to vertically depressed,

1–2 mm wide; valves broadly triangular, obtuse or acute, basally enclosed or rim level, apically rim level or exerted, raised at 45–90°. Seeds semi-glossy to dull, brownish black, somewhat angular to rounded, elliptical, regularly shallowly reticulate; hilum ventral. Chaff brown.

A widespread and locally dominant tree across a major part of the monsoon tropics, but not including Cape York Peninsula. Two geographically separate subspecies are recognised.

14A. *Eucalyptus pruinosa* Schauer subsp. *pruinosa*

Adult leaves 50–150 mm long, 30–90 mm wide. Peduncles 6–25 mm long, 1–2 mm diam. Pedicels 2–8 rarely to 22 mm long. Buds 7–12 mm long, 4–6 mm diam.; calyptra hemispherical, rostrate, 1/2–1 times as long as hypanthium. Fruits 7–12 mm long, 6–10 mm diam.

Hybrids are recorded with *E. tropica*, *E. limitaris* and *E. microtheca*.

Distribution: the gulf district of north-western Queensland, extending west through the Northern Territory at corresponding latitudes, and into the south-eastern Kimberley region of Western Australia (Fig. 18).

Ecology: a locally dominant species in low open savanna woodlands or shrublands, often the only tree species in the community, frequently with *Triodia* understorey. Substrate varies from sand to sandy loam, often with laterite and usually on more or less flat but well-drained sites.

Conservation status: widespread and locally abundant, not considered to be at risk.

Selected specimens (from 39 examined): Northern Territory: 132.3 km SE of Fitzroy Crossing towards Halls Creek, *Brooker* 10784, 24 Apr 1991 (CANB, DNA, NSW, PERTH); 7 miles [11.2 km] NW Alexandria HS, *Chippendale* NT 1947, 22 Mar 1956 (DNA, NSW); 8.6 miles [12.2 km] W of Soudan HS, *Chippendale* NT 3829 & *Johnson*, 2 Oct 1957 (DNA, NSW); 79.1 miles [126.5 km] NE Tanami, *Chippendale* NT 5722, 13 Apr 1959 (DNA, NSW); 10 km S of Ti Tree, *Fox s.n.*, June 1986 (NSW301476); Robinson River station, *Gillins* 1301, June 1967 (NSW); 110 km SW of Hooker Creek toward Tanami, *Gillins* 2352, Aug 1971 (NSW); 3 km along track to Wollogorang from 12 Mile Waterhole, *Halford* 841120, 29 Nov 1984 (DNA, NSW); 8.4 km south of Banka Banka on Stuart Highway, *Hill* 881, *Johnson & Benson*, 13 July 1984 (NSW, CANB); 6 miles [9.6 km] NW of the

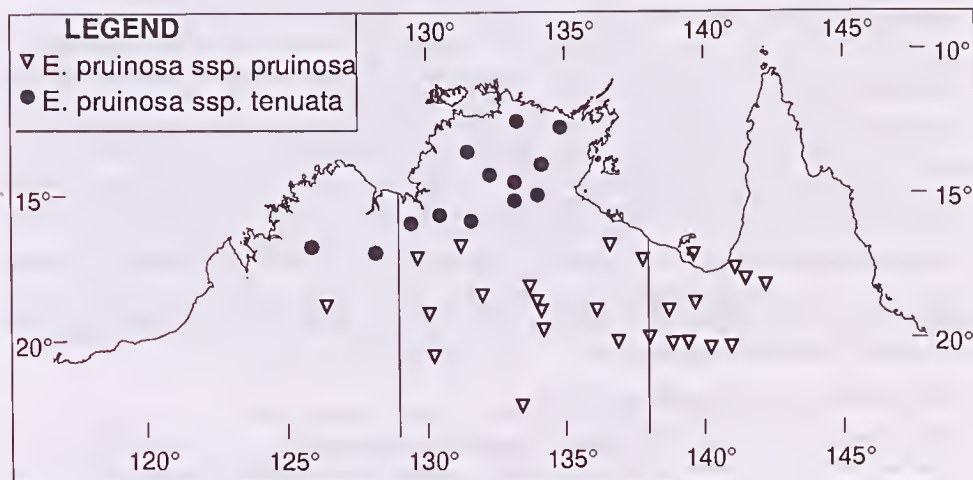


Fig. 18. Distribution of *E. pruinosa* subsp. *pruinosa*, subsp. *tenuata*.

Granites Township, *Lazarides* 6256, 22 Apr 1957 (CANB, NSW); 15 miles [24 km] NW of Limbunya station, *Perry* 2312, 30 June 1949 (CANB, NSW); between Renner's [Renner] Springs and Powells Creek, *White* 7, 30 May 1922 (NSW).

Queensland: Camooweal, *Blake* 8849, 1 May 1935 (BRI, CANB, NSW, NT); Dalgonally to Fort Constantine, *Blake* 12646, 20 Aug 1936 (BRI, NSW); 7 miles [11.2 km] N of Normanton on the Karumba road, *Carolin* 8722, 18 Apr 1974 (NSW); Sandy Creek, 2 miles [3.2 km] from Nardoo towards Gregory Downs, *Carolin* 8884, 26 Apr 1974 (NSW); Normanton to Karumba road between Normanton and Maggieville, *Clarkson* 2696 b, 6 Nov 1979 (BRI, CANB, NSW); Riversleigh Holding [c. NE of Camooweal], *Gittins* 800, June 1963 (NSW); 27 miles [43.2 km] NW of Cloncurry township, *Lazarides* 4307, 11 Mar 1954 (CANB, NSW); 37 miles [59.2 km] of Croydon township, *Speck* 4762, 21 July 1954 (CANB, NSW); about 25 miles [40 km] W [i.e. NW] of Croydon, *Stocker* 741, 3 June 1971 (QRS, NSW).

15B. *Eucalyptus pruinosa* Schauer subsp. *tenuata* L.A.S. Johnson & K.D. Hill, subsp. nov.

Ab subspecie *pruinosa* distinguitur: alabastra minora, pedicelli graciles delicatique et fructus parvi.

Type: Northern Territory: 15 km E of Timber Creek roadhouse on highway, *K.D. Hill* 919, *L.A.S. Johnson & D. Benson*, 21 July 1984 (holo NSW; iso CANB, DNA, PERTH).

Adult leaves 25–110 mm long, 15–60 mm wide. Peduncles 5–18 mm long, less than 1 mm diam. Pedicels 4–8 mm long. Buds 6–8 mm long, 3–4 mm diam.; calyptra conical, acute, about as long as hypanthium. Fruits 5–8 mm long, 4–6 mm diam.

Distinguished from the type subspecies by the small buds, the slender, delicate pedicels and the small fruits.

Distribution: northern, wetter parts of the Northern Territory and corresponding northern parts of the Kimberley region of Western Australia (Fig. 18).

Ecology: habitat is generally similar to that of the type subspecies, although often on more sloping country and on a wider range of soils, some quite heavy. Habitats of this subspecies tend to be locally drier sites with low open woodland or shrubland, in a region of taller and more closed vegetation.

Conservation status: widespread and locally abundant, not considered to be at risk.

The epithet is from the Latin *tennis*, slender, with the Latin adjectival termination *-atus*, in reference to the slender pedicels and peduncles.

Selected specimens (from 25 examined): Northern Territory: Roper Valley station, *Bateman* 11, 11 June 1950 (DNA, NSW); 15 miles [24 km] W of Katherine towards Wyndham, *Brooker* 3142, 17 June 1971 (CANB, NSW); 12 m [19.2 km] west of Katherine Gorge, *Brooker* 3154, 17 June 1971 (CANB, NSW); Saddle Creek, 71 miles [113.6 km] by road from Timber Creek Police Stn towards Kununurra, *Brooker* 4205, 29 Oct 1973 (CANB, NSW); 1 km W of Elsey Creek on Roper Road, *Brooker* 6213, 5 Apr 1979 (CANB, NSW); 17 miles [27.2 km] NE of Mainoru, *Cole* 81 & *Provan*, (CANB, NSW); 14 miles [22.4 km] NNE Mainoru, *Maconochie* 1430, 14 June 1972 (DNA, NSW); Maude Creek area, *Speck* 1621, 3 Sep 1961 (CANB, NSW); 13 miles [20.8 km] S of Delamere station, *Perry* 2850, 31 May 1952 (CANB, NSW); Canopy Rock, Mountain Valley Stn, *Swinbourne* 682, 25 Mar 1963 (NSW); 50 km S Mataranka, Stuart Highway, *Wightman* 1504, 2 July 1984 (DNA, CANB, K, NSW).

Western Australia: Radigans Bore [near] Bow River, *Sainty & Lillyman* s.n., 9 June 1982 (NSW); Telegraph Creek about 160 km NNE of Halls Creek, *Briggs* 3677, 19 June 1970 (NSW); 10 km SW Mt Barnett St [station], Kimberleys, *Guymer* 606, 6 Sep 1976 (BRI, NSW).

Intergrades between the subspecies

Selected specimens (from 12 examined): Northern Territory: 95.7 km SE of Fitzroy Crossing, Ngumban Cliff area, *Brooker* 10782, 24 Apr 1991 (CANB, NSW, PERTH); 20 miles [32 km] SW Borroloola, *Hill* 566, 2 Sep 1911 (NSW); 6.0 km W of Montejinni turnoff on Buchanan Highway, *Hill* 1009, *Johnson & Benson*, 4 Aug 1984 (NSW).

Western Australia: Rosewood station, *Beard* 5664, 29 June 1968 (PERTH, NSW); Mt Nyulasy, 115 km S of Kununurra - Wyndham rd on Halls Creek rd, *Hill* 933, *Johnson & Benson*, 22 July 1984 (NSW); 93 km SE of Fitzroy Crossing on highway, *Hill* 984 *Johnson & Benson*, 2 Aug 1984 (NSW, CANB, DNA, PERTH); opposite Kununurra Airstrip, *Palzer* 713, 16 Sep 1966 (CANB, NSW); near Rexona Bore, 26 miles [41.6 km] SSE of Cherrabun station, *Lazarides* 6480, 14 Aug 1959 (CANB, NSW).

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